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Quality Assurance Program Plan for Radionuclide Airborne Emissions Monitoring

L. W. Vance

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Westinghouse Hanford Company
P.O. Box 1970
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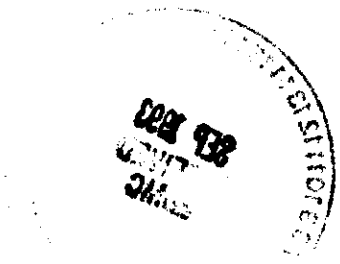

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Part 1

QUALITY ASSURANCE FOR RADIONUCLIDE AIRBORNE EMISSIONS MONITORING

L. W. Vance

ABSTRACT

This Quality Assurance Program Plan identifies quality assurance program requirements and addresses the various organizations and their particular responsibilities in regards to sample and data handling of airborne emissions.

The Hanford Site radioactive airborne emissions requirements are defined within Title 40, Protection of the Environment, Code of Federal Regulations, Part 61, "National Emissions Standards for Hazardous Air Pollutants," Subpart H, (EPA 1991). Reporting of the emissions to U.S. Department of Energy is performed in compliance with requirements of U.S. Department of Energy Order 5400.1, General Environmental Protection Program (DOE 1988a).

This Quality Assurance Program Plan, is prepared in accordance with and to the requirements of QAMS-004/80, Guidelines and Specifications for Preparing Quality Assurance Program Plans (EPA 1983).

Title 40 CFR Part 61, Appendix B, Method 114, "Quality Assurance Methods," specifies the quality assurance requirements and that a program plan should be prepared to meet the requirements of this regulation. This document identifies NESHAP responsibilities and how the Environmental, Safety, Health, and Quality Assurance Division will verify that the methods are properly implemented.

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APPENDICES

LIST OF FIGURES

LIST OF TERMS

CFR	Code of Federal Regulations
CSS	Central Support Services
DOE	U.S. Department of Energy
ECA	Environmental Compliance Assurance
EEM	Effluent Emission Monitoring
EMSI	Environmental Management Systems Integration
EPA	Environmental Protection Agency
ESH/QA	Environmental, Safety, Health, and Quality Assurance
ESQA	Environmental Services Quality Assurance
ESQD	ESQ Data
FQA	Facility Quality Assurance
JCS	job control system
NESHAP	"National Emission Standards for Hazardous Air Pollutants"
PAL	Processing and Analytical Laboratory
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QASR	Quality Assurance Standards & Requirements
QCA	Quality Compliance Assurance
QC	quality control
QI	Quality Instruction
QR	Quality Requirement
RA	Regulatory Analysis
RPI	Regulatory Program Integration
RR	Restoration and Remediation
SQA	Support Quality Assurance
TWRS	Tank Waste Remediation System
WHC	Westinghouse Hanford Company
WDOH	Washington State Department of Health

QUALITY ASSURANCE PROGRAM PLAN FOR RADIONUCLIDE AIR EMISSIONS MONITORING

1.0 INTRODUCTION

This Quality Assurance Program Plan (QAPP) describes the quality assurance requirements and responsibilities for radioactive airborne emissions measurements activities from regulated stacks are controlled at the Hanford Site. This QAPP is prepared in accordance with and to the requirements of QAMS-004/80, *Guidelines and Specifications for Preparing Quality Assurance Program Plans* (EPA 1983).

Radioactive airborne emission measurement requirements are defined in Subpart H of Title 40, *Code of Federal Regulations* (CFR), Part 61, "National Emission Standards for Hazardous Air Pollutants" (NESHAP) (EPA 1991). Detailed monitoring requirements apply to stacks exceeding 1% of the standard of 10 mrem annual effective dose equivalent to the maximally exposed individual from operations of the Hanford Site.

Title 40 CFR Part 61, Appendix B, Method 114, "Quality Assurance Methods," specifies the quality assurance (QA) requirements and that a QAPP should be prepared to meet the requirements of this regulation.

The QAPP will be updated annually or when organizational changes and/or responsibilities warrant a revision.

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2.0 QUALITY ASSURANCE POLICY STATEMENT

Westinghouse Hanford Company (WHC) shall maintain and verify a prevention-oriented QA program to ensure that WHC products and services meet requirements, are fit for use, and satisfy customer expectations. As part of prevention orientation, the QA program shall provide measurements of performance, establish criteria, and encourage changes that improve quality and productivity.

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3.0 ENVIRONMENTAL, SAFETY, HEALTH, AND QUALITY ASSURANCE MANAGEMENT

Independent oversight verification activities associated with the radioactive airborne emission measurements are controlled by the ESH/QA Division for WHC. The organizations within this Division that perform these oversight activities, and their interfaces, are figures in Section 7.0.

QA surveillances will be performed and controlled in accordance with WHC-CM-4-2, Quality Requirement (QR) 10.0, "Inspection," and QI 10.4, "Surveillance" (WHC 1988).

The sections that follow describe the responsibilities of these organizations as they relate to radioactive air emissions measurements.

3.1 ESQ COMPLIANCE ASSURANCE

The organizational chart for the ESQ Compliance Assurance is referenced in figure number 2.

3.1.1 Environmental Compliance Assurance

The Environmental Compliance Assurance (ECA) group maintains and implements a comprehensive environmental oversight program to independently verify that Westinghouse Hanford operations are conducted in compliance with applicable environmental regulations, U.S. Department of Energy (DOE) orders, and Westinghouse Hanford management control systems.

The ECA group schedules and performs oversight activities (audits and appraisals) in accordance with requirements specified in WHC-CM-7-6, Sections 4.0, 5.0, 6.0, 7.0, 10.0, and 13.0 (WHC 1989a), and Quality Instruction (QI), 18.4 of WHC-CM-4-2, *Quality Assurance Manual* (WHC 1988).

The ECA group will schedule and perform at least one annual audit/appraisal of air emissions activities. Specific activities to be audited/appraised will be selected using a risk-based oversight schedule prioritization system. Annual ECA audit/appraisal activities will, to the extent possible, be integrated with those of the Westinghouse Hanford QA and Safety oversight organizations.

3.1.2 Quality Compliance Assurance

The Quality Compliance Assurance (QCA) group schedules and performs the Westinghouse Hanford QA audit activities. Audits are performed in accordance with requirements specified in WHC-CM-4-2, QR 18.0, "Audits;" QI 18.1, "Audit Programming and Scheduling;" and QI 18.4, "Integrated Audits/Appraisals" (WHC 1988).

In accordance with QI 18.1, paragraph 4.2, QA group managers are responsible for determining internal audit needs. The Environmental Management Systems Integration (EMSI) group manager will interface with the other QA managers and other facility managers to decide on the effluent stack QA auditing needs. This will include at least one annual system audit of the stack sample collections and the analytical laboratory. It is permissible to do these as an integrated audit with the ECA group.

3.2 QUALITY ASSURANCE

The organizational chart for QA is referenced in Figure 3. Surveillances will be performed and controlled in accordance with WHC-CM-4-2, Quality Requirement (QR) 10.0, "Inspection," and QI 10.4, "Surveillance" (WHC 1988).

3.2.1 Environmental Management Systems Integration

The Environmental Management Systems Integration (EMSI) group is responsible for administering this QAPP to meet the requirements for radionuclide air emissions. This effort includes verifying that regulatory QA requirements are included and interfacing with the regulatory analysis group to ensure that regulatory updates are incorporated into the document.

The EMSI group interfaces with the Regulatory Support Organization reviewing and approving documents that define environmental regulatory quality requirements. EMSI also reviews and approves regulatory implementation documents and surveills the activities of the groups in this organization.

This group provides general direction and over sight of NESHAPs QA activities. This includes training to other QA personnel and surveillances as needed to verify that activities are controlled.

3.2.2 Environmental Services Quality Assurance

The ESQA group is responsible for surveillance of activities associated with control of laboratory analysis activities. This includes the following:

- Reviewing and approving laboratory analytical procedures for QA/quality control (QC) requirements
- Surveillance of laboratory activities associated with the radionuclide emissions stack monitoring
- Participating as a QA/QC specialist in laboratory reviews and audits.

3.2.3 Support Quality Assurance

The Support Quality Assurance (SQA) group is responsible for review, approval, and surveillance of activities performed by the following organizations:

- Policy and Procedures group (see Section 6.2.1)
- Recall Systems Maintenance Engineering (see Section 6.2.6.3)
- Procedure Development/Control (see Section 6.2.6.2)

3.2.4 Quality Assurance Standards and Requirements

The Quality Assurance Standards And Requirements (QASR) group is responsible for the support of sitewide activities maintaining compliance with 40 CFR 61, Subpart H. The QASR group provides for the documentation of the WHCs Quality Assurance Program as required by 40 CFR 61.93 (b)(2)(iv) and (5)(v). The specific requirements for this program are listed in Section 4.0 of 40 CFR 61, Appendix B, Method 114, "Test Methods for Measuring Radionuclides Emissions from Stationary Sources."

3.2.5 Facility Quality Assurance

The Facility Quality Assurance (FQA) group consists of QA engineers from PFP Quality Assurance, FFTF Quality Assurance and Transitional Facilities Quality Assurance groups, all performing the same function. The FQA engineers are responsible for interfacing with facility cognizant engineers in reviewing and approving facility radioactive air monitoring documentation and verifying its implementation. The activities that the FQA engineer reviews, approves, and verifies are described in Sections 6.2.1 and 6.2.6.1 of this document.

3.2.6 Tank Waste Remediation System Quality Engineering

The Tank Waste Remediation System (TWRS) Quality Engineering group is responsible for interfacing with facility cognizant engineers in reviewing and approving facility radioactive air monitoring documentation and verifying its implementation. The activities that the TWRS Quality engineer reviews, approves, and verifies are described in Sections 6.2.1 and 6.2.6.1 of this document.

3.2.7 Engineering Applications Quality Assurance

The Engineering Applications Quality Assurance group is responsible for interfacing with facility cognizant engineers in reviewing and approving facility radioactive air monitoring documentation and verifying its implementation. The activities that the EAQA engineer reviews, approves, and verifies are described in Sections 6.2.1 and 6.2.6.1 of this document.

3.2.8 Waste Operations Quality Assurance

The Waste Operations Quality Assurance group is responsible for interfacing with facility cognizant engineers in reviewing and approving facility radioactive air monitoring documentation and verifying its implementation. The activities that the WOQA engineer reviews, approves, and verifies are described in Sections 6.2.1 and 6.2.6.1 of this document.

4.0 DOCUMENT CONTROL AND RECORDS

Records of effluent sample analysis performed by the laboratory and used in the generation and verification of regulatory reports shall be retained by the laboratory. The effluent stack flow measurements of each facility stack shall be retained by the facilities. These records will be controlled in accordance with WHC-CM-4-2, QR 6.0, "Document Control," and QR 17.0, "Quality Assurance Records" (WHC 1988).

4.1 QUALITY ASSURANCE

The QA groups perform surveillances to verify the activities noted above. The QA groups will support these audits under the direction of the QCA group.

The requirements for the control and documentation of surveillances is addressed in WHC-CM-4-2, QI 10.4, "Surveillance" (WHC 1988). This procedure specifies the requirements for surveillance preparation, distribution, scheduling, and controls.

All surveillances, with any noted deficiencies, are routed to the Environment, Safety, Quality Data (ESQD) organization, which tracks and verifies that deficiencies are addressed. The ESQD group interfaces with oversight organizations and controls their activities in accordance with WHC-CM-4-2, QI 16.6.

4.2 ESQ COMPLIANCE ASSURANCE

4.2.1 Environmental Compliance Assurance

Section 13 of WHC-CM-7-6 (WHC 1989a), and QI 18.4 of WHC-CM-4-2 (WHC 1988) specify how ECA oversight documentation (in-process records and QA records) generated during oversight activities will be maintained and controlled.

4.2.2 Quality Compliance Assurance

The requirements for the control and documentation of QCA integrated audits are addressed in WHC-CM-4-2, QI 18.4, "Integrated Audits/Appraisals" (WHC 1988). This procedure specifies audit/appraisal preparation, schedule requirements, and control.

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5.0 ORGANIZATION AND PERSONNEL QUALIFICATIONS

All organizations and their charters are included in WHC-CM-1-2, *Organization Charts and Charters* (WHC 1990a). All personnel working within an organization and their job titles are included in a divisional/departmental organization chart. See Section 7.0 of this document for individual Organizational Charts.

The job classification, training, and indoctrination requirements are specified in WHC-CM-1-3, MRP 4.22 (WHC 1990b). Each manager maintains employee records, documenting needed training completed for each job assignment, in accordance with this requirement.

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6.0 RADIOACTIVE AIR EMISSIONS MEASUREMENT QUALITY ASSURANCE PROJECT PLANS IMPLEMENTATION

6.1 INTRODUCTION

The NESHAP (EPA 1991) suggests that a Quality Assurance Project Plan (QAPjP) be prepared to the requirements of 40 CFR 61, Appendix B, Method 114, for measuring radioactive air emissions. These QAPjP requirements are addressed below.

- Each organization involved with the NESHAP program, and a description of its activities, is addressed in Section 6.2 of this document. Their responsibilities for the 40 CFR 61 Appendix B, Method 114, Section 4.0, "QA Methods," are specified on a point-by-point basis appended to this document.

- The EEM organization has issued a separate QAPjP, WHC-EP-0528, prepared in accordance with the format of QAMS-005/80 (EPA 1983). This document addresses the appropriate NESHAP requirements (see Section 6.2.5) and provides technical support to the radioactive air emissions measurement program.

- Facility organizations that are responsible for specific stacks shall prepare and maintain a NESHAP, Appendix B, Method 114, "QA Method," point-by-point implementation document (see Section 6.2.7). These are appended to this document as they are completed.

- For those organizations that work with all stacks, the implementing information is included in this document. This includes the efforts of the Health Physics and Central Support Services organizations (see Sections 6.2.1 and 6.2.6).

- The laboratory point-by-point implementation is appended to this document (see Section 6.2.2).

6.2 ORGANIZATION AND RESPONSIBILITIES

All organizational structure, functional responsibilities, levels of authority and lines of communication that could affect the sampling and analysis activities are addressed in Section 7.0 of this document. Figures 1 through 7 provides the organizational structure and Figure 8 shows the organizational relationships involved in the radionuclide sampling, effluent flow measurement, and analysis activities.

The ESH/QA oversight interfaces and responsibilities are addressed in Sections 3.0 and 4.0.

The organizational responsibilities for 40 CFR 61, Appendix B, Method 114, Section 4.0, "Quality Assurance Methods" (EPA 1991) are described below. These descriptions define the Method 114 point-by-point information indicating each organizations area of responsibility.

6.2.1 Health Physics

Health Physics (see Figure 4) provides the sampling effort for the radionuclide air emissions under the technical direction of the facility cognizant engineer. The sampling collection, tracking, and handling procedures for the effluent samples are contained in WHC-IP-0692 (WHC 1991a). Policies and Procedures group prepares the procedures for sample collection and the sample tracking system that are used by the Health Physics organization.

The sampling activities should be done in accordance with the stack monitoring and sampling requirements of 40 CFR 61, Appendix B, Method 114 (EPA 1991). The QA activities that are included in Method 114 and performed by this group are described below.

- Section 4.3.4 describes the sample collection requirements.
- Section 4.6 covers the sample tracking system for positive identification of samples from sample collection to delivery to the laboratory, as well as sample handling and preservation procedures to maintain the integrity of samples during collection and storage.

6.2.2 Laboratories

Processing and Analytical Laboratories (PAL) (see Figure 6) maintain that the radionuclide air emissions samples will be analyzed in accordance with applicable regulations. The specific radionuclides to be analyzed for are determined by Effluent Emission Monitoring (EEM) with the assistance of the facility cognizant engineer.

Laboratories shall have a QA plan and analytical procedures that meet the requirements of 40 CFR 61, Appendix B, Method 114 (EPA 1991). The QA activities identified in Method 114 that must be addressed in laboratory QA plans are as follows:

- Calibration activities specified by the Radionuclide Analysis Method in Method 114
- Section 4.3.5, the calibration procedures and frequency of calibration required for the analytical procedures used by the laboratory
- Section 4.5, a quality control program to evaluate and track the quality of emissions measurement data
- Section 4.6, a sample tracking system to provide for positive identification of samples and data through all phases of sample receipt, analysis, and reporting
- Section 4.6, a sample control system to maintain the integrity of samples during storage and analysis.

6.2.3 Regulatory Analysis

Regulatory Analysis (RA) within the Restoration and Remediation Division (see Figure 5) is responsible for the WHC-CM-7-5, Environmental Compliance manual which establishes the environmental compliance requirements and guidelines for WHC in conjunction with applicable DOE Orders and federal, state, and local laws and regulations. Regulatory Analysis also provides guidance on the interpretation of regulations and interfaces with the regulatory agencies to resolve regulatory issues.

6.2.4 Regulatory Program Integration

Regulatory Program Integration (RPI) within the Restoration and Remediation Division (see Figure 5) is responsible for reviewing WHC generated documents affecting the design, construction, and operation of stack monitoring systems subject to the requirements of 40 CFR 61. Such documents include, but are not limited to, procurement specifications, design drawings, facility effluent monitoring plans, and engineering change notices. RPI reviews this documentation against the monitoring requirements of 40 CFR 61 with the goal of ensuring sitewide compliance.

6.2.5 Effluent Emission Monitoring

The Effluent Emissions Monitoring (EEM) group (see Figure 5), within the Restoration and Remediation (RR) organization, has the following responsibilities:

- Provide technical support for radioactive air emissions sampling and monitoring
- Provide technical requirements of radioactive air sample analysis; sampling schedule, list of specific radionuclides to be analyzed, and lower limits of detection
- Compile radioactive air sampling data and flow rates to prepare regulatory reports
- Verify sample analysis parameters received from the laboratory.
- Document records of radioactive air emissions in annual reports cleared for public access.

The QAPjP WHC-EP-0528 addresses the following sections of 40 CFR 61, Appendix B, Method 114 (EPA 1991):

- Section 4.3.1, provide identification numbers for sample locations
- Section 4.3.5, specify the analysis that is to be performed for each stack
- Section 4.4, provide the data quality objectives for the sampling and analysis activities.

6.2.6 Central Support Services

The effluent flow measurement activities are performed by the Central Support Services group (see Figure 7) under the control of the facility cognizant engineer.

The QA activities from Method 114 (EPA 1991) that are performed by the organizations described below, through Central Support Services, are described in the paragraphs that follow.

6.2.6.1 Ventilation and Balance. The effluent flow measurements are performed by this group in accordance with procedures that are included in a Job Control System (JCS) (see WHC-CM-8-8 [WHC 1989b]) work package. These procedures are currently being updated to meet the requirements of 40 CFR 61, Appendix B, Method 114, (EPA 1991) Section 4.3.7. The facility cognizant engineer is responsible for the JCS work package that is transmitted to the ventilation and balance organization.

The data collected from this activity are provided to the facility cognizant engineer who is responsible for verifying and transmitting this information to the EEM group.

6.2.6.2 Procedure Development and Control. The procedures used for the effluent measurements and facility equipment calibrations are prepared by this group in accordance with the requirements of 40 CFR 61, Appendix B, Method 114, (EPA 1991), Section 4.3.7. Some of these procedures are generic, with the plant-specific information being included in the JCS package.

The development and control of these procedures are addressed in WHC-CM-8-10, Section 06-03 (WHC 1990c).

6.2.6.3 Recall Systems Maintenance Engineering. The scheduling of calibration for the continuous stack flow measurement equipment is controlled by this group in accordance with the requirements of 40 CFR 61, Appendix B, Method 114, (EPA 1991), Section 4.3.7, This scheduling information is forwarded to the facility planner/scheduler who prepares the JCS work package under the direction of the facility cognizant engineer. This work package is required for the maintenance forces to perform the calibration(s). The completed calibration information is returned to Recall Systems Maintenance Engineering for tracking purposes.

The control of these calibration scheduling and tracking activities is addressed in WHC-CM-8-2, Section 2.0 (WHC 1991b).

6.2.7 Facilities

The facility cognizant engineers (see Figure 6) are responsible for defining how the stack sampling, analysis, and effluent flow measurement requirements are implemented. The facility cognizant engineer prepares the

radionuclide stack point-by-point implementation that addresses the sections of 40 CFR 61, Appendix B, Method 114 (EPA 1991), described below.

- Section 4.2 describes the administrative controls that are used at the facility to ensure a prompt response in the event that emission levels increase because of unplanned operations.
- Section 4.3.1 specifies the number of sample points and the rationale for sample site selections.
- Section 4.3.2 describes sampling probes and representativeness of samples.
- Section 4.3.4 identifies the sampling procedure(s) to be used and sampling frequency.
- Section 4.3.6 describes the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.
- Section 4.3.7 describes the effluent flow rate measurement system, including frequency of measurements. The facility cognizant engineer is responsible for verifying these flow rates and transmitting the information to the EEM organization.

6.2.8 Other Support Contractors

Procurement of the services of other subcontractors to support radionuclide effluent activities addressed in this QAPP may be initiated by WHC. Such services shall be in compliance with standard WHC procurement procedures requirements. All work shall be performed in accordance with approved QA plans and/or procedures, subject to the controls of WHC-CM-4-2, QR 4.0, "Procurement Document Control," and QR 7.0, "Control of Purchased Items and Services," (WHC 1988).

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7.0 ORGANIZATIONAL CHARTS AND FIGURES

The following eight charts show in more detail how the pertinent organizations fit together within the WHC structure. Organizational codes are included as references.

The President of WHC has an organization code of 01000 and all subsequent sequences are manager levels from Level 1 down to Level 4. The Level 1 managers are D0000, Level 2 are DD000, Level 3 are DDD00 and Level 4 are DDDD0. The D represented within an organizational code signifies a digit or an alpha character.

Figure 8, Emission Sampling and Analytical Implementation is a flow chart representing the different groups involved with the process of sample and data handling.

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Figure 1. Organizational Chart for WHC Senior Management.

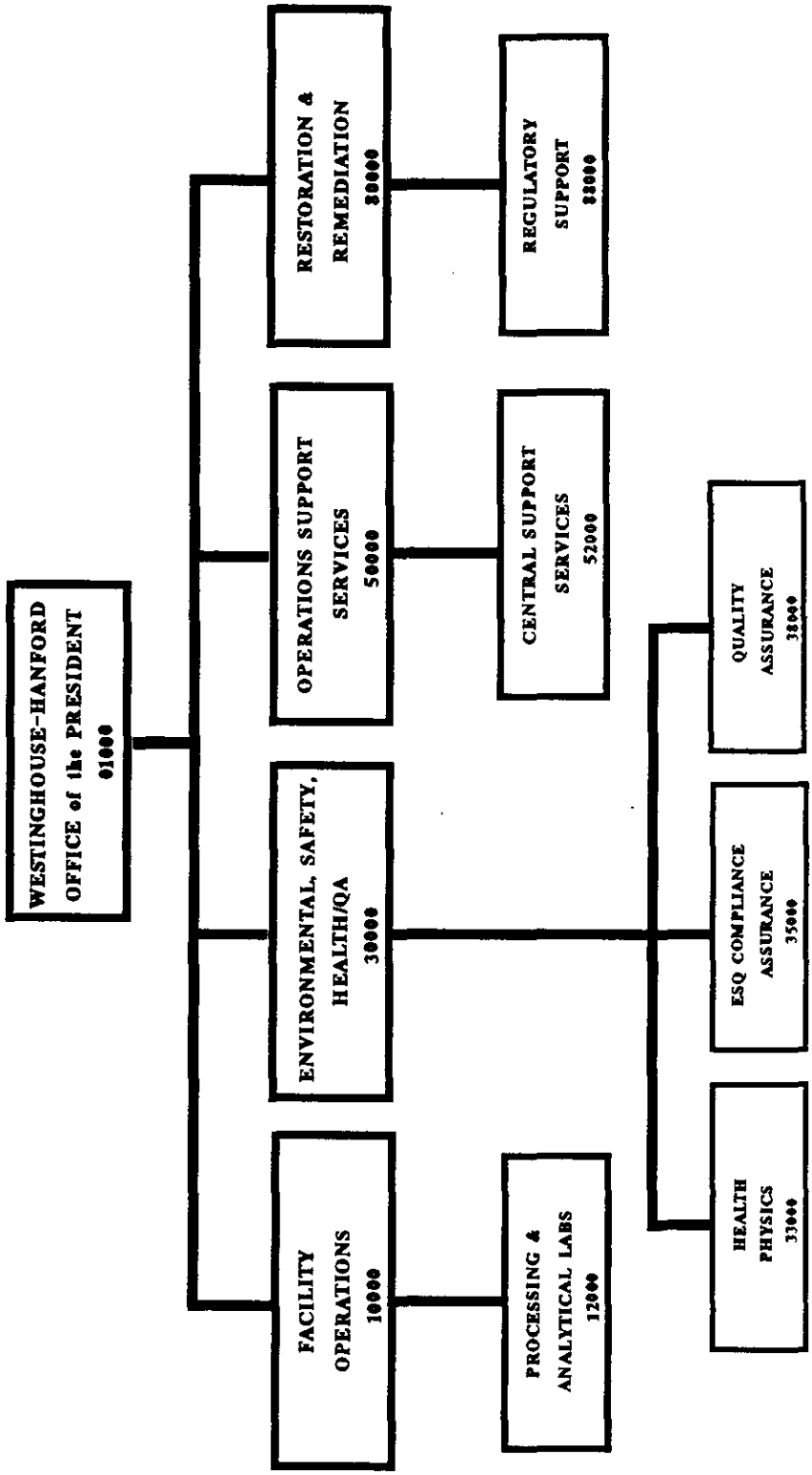

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Figure 2. Organizational Chart for ESQ Compliance Assurance.

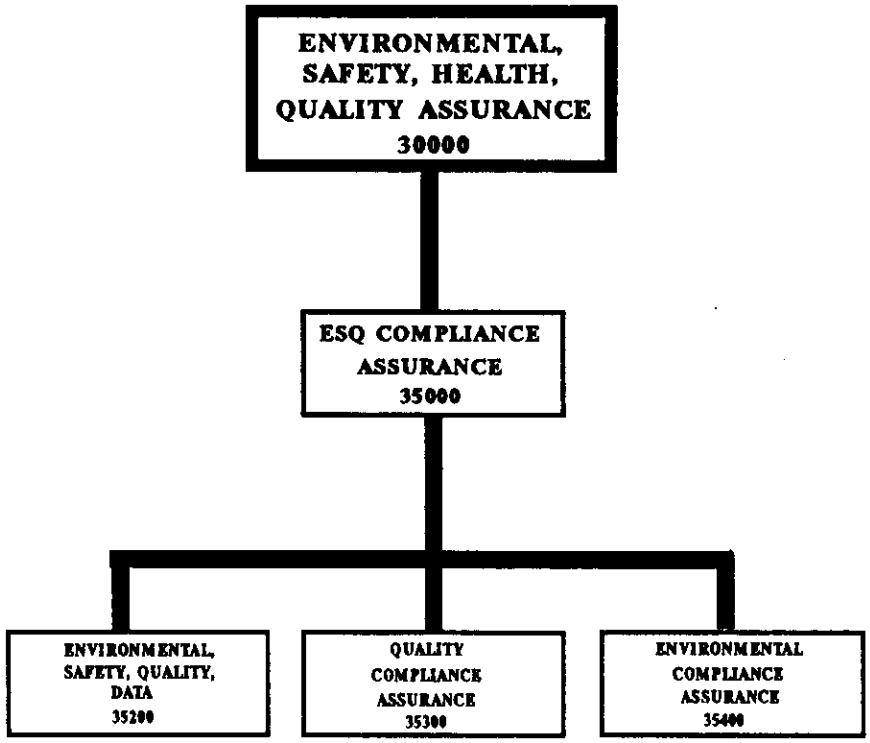

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Figure 3. Organizational Chart for Quality Assurance.

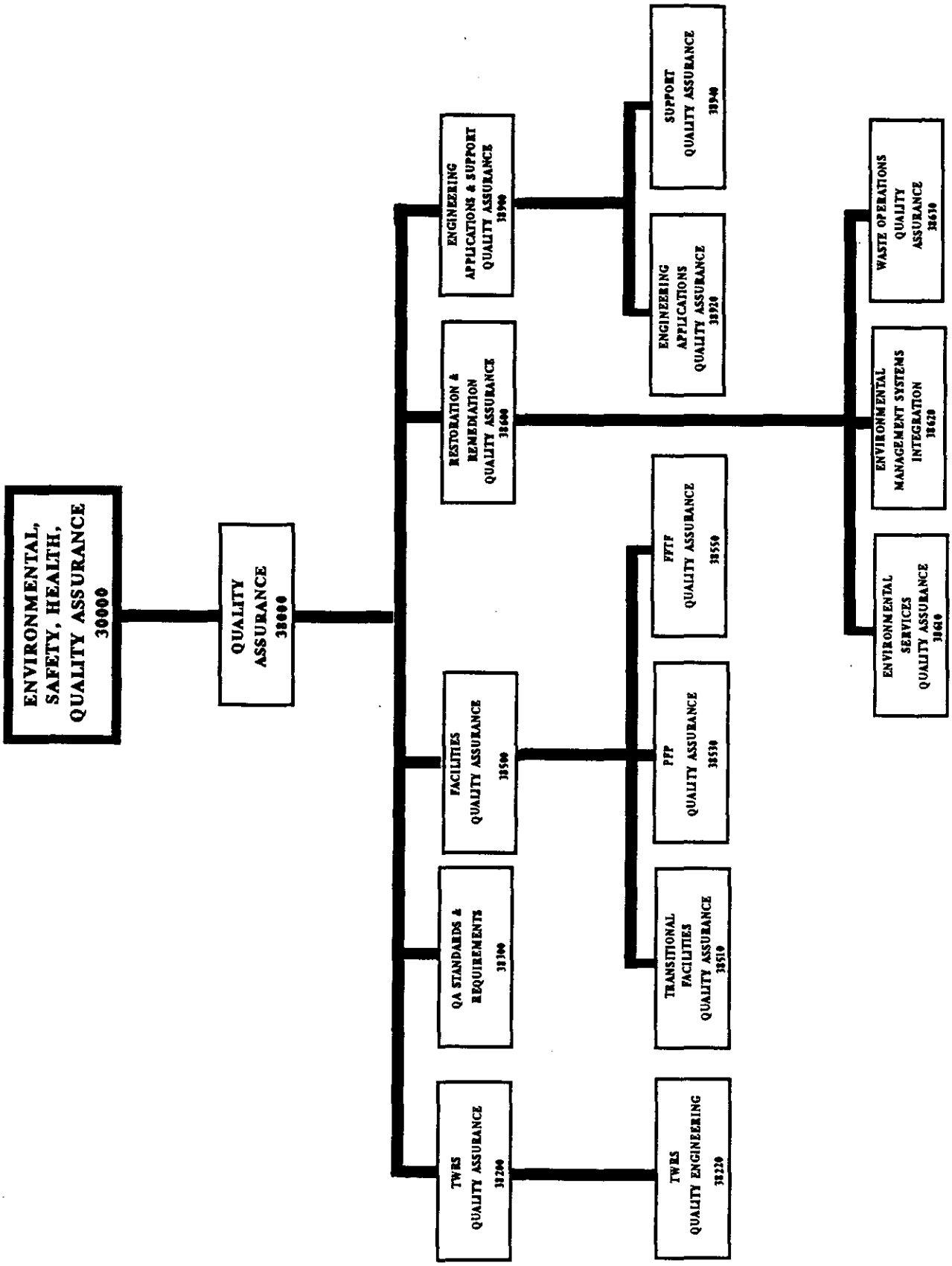

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Figure 4. Organizational Chart for Health Physics.

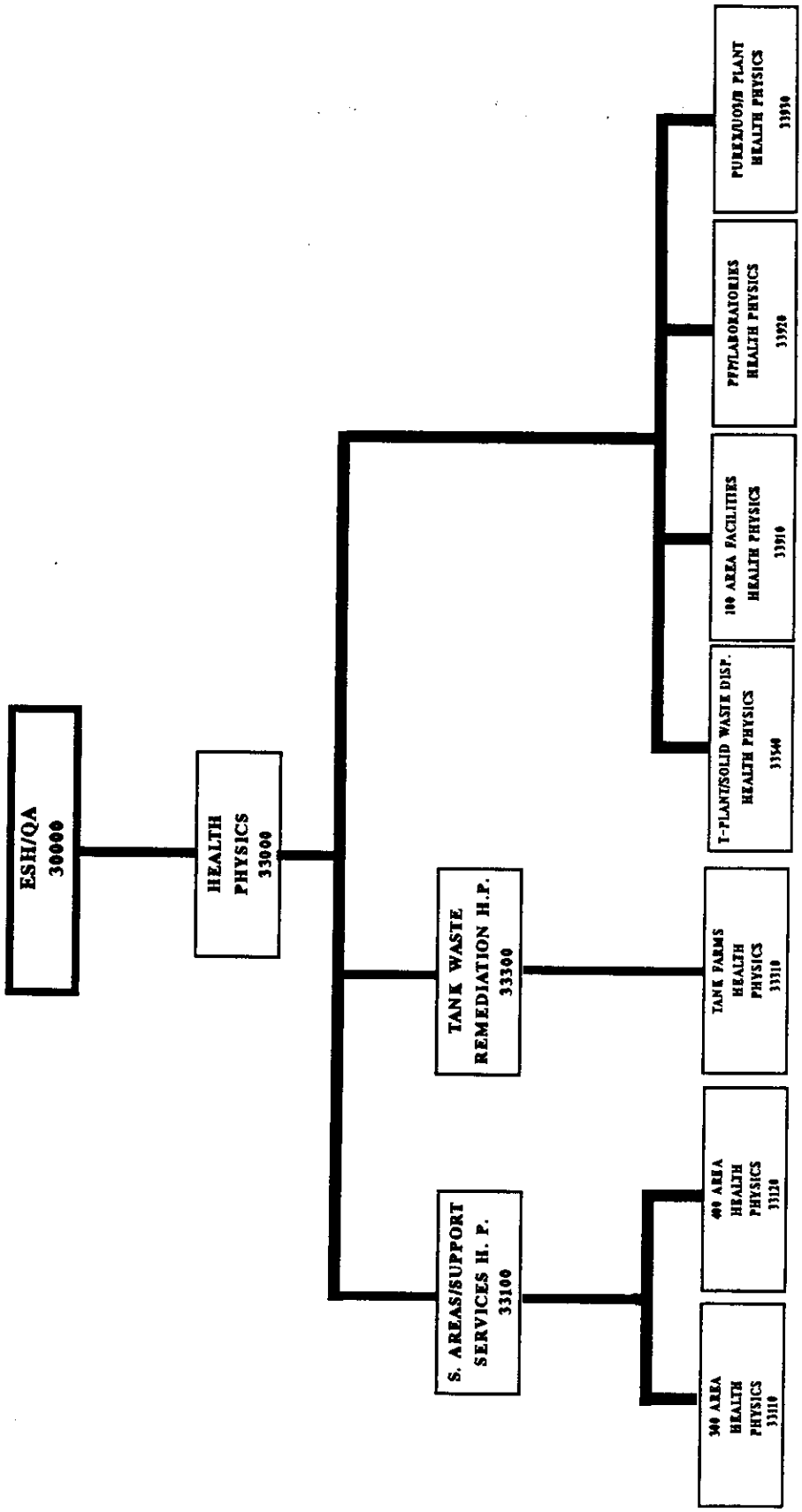

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Figure 5. Organizational Chart for Restoration & Remediation.

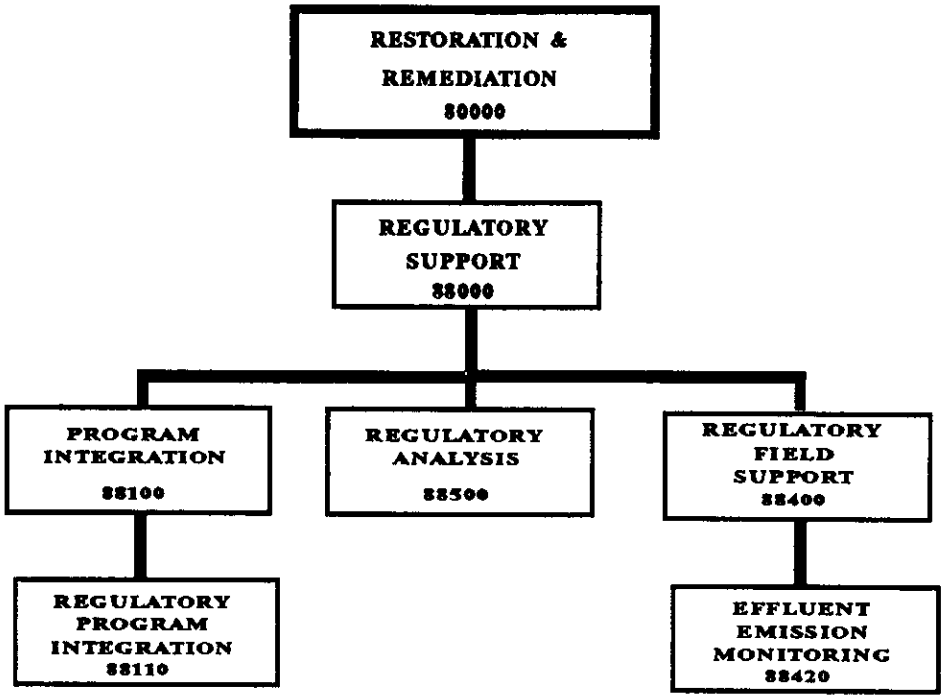

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Figure 6. Organizational Chart for Facility Operations.

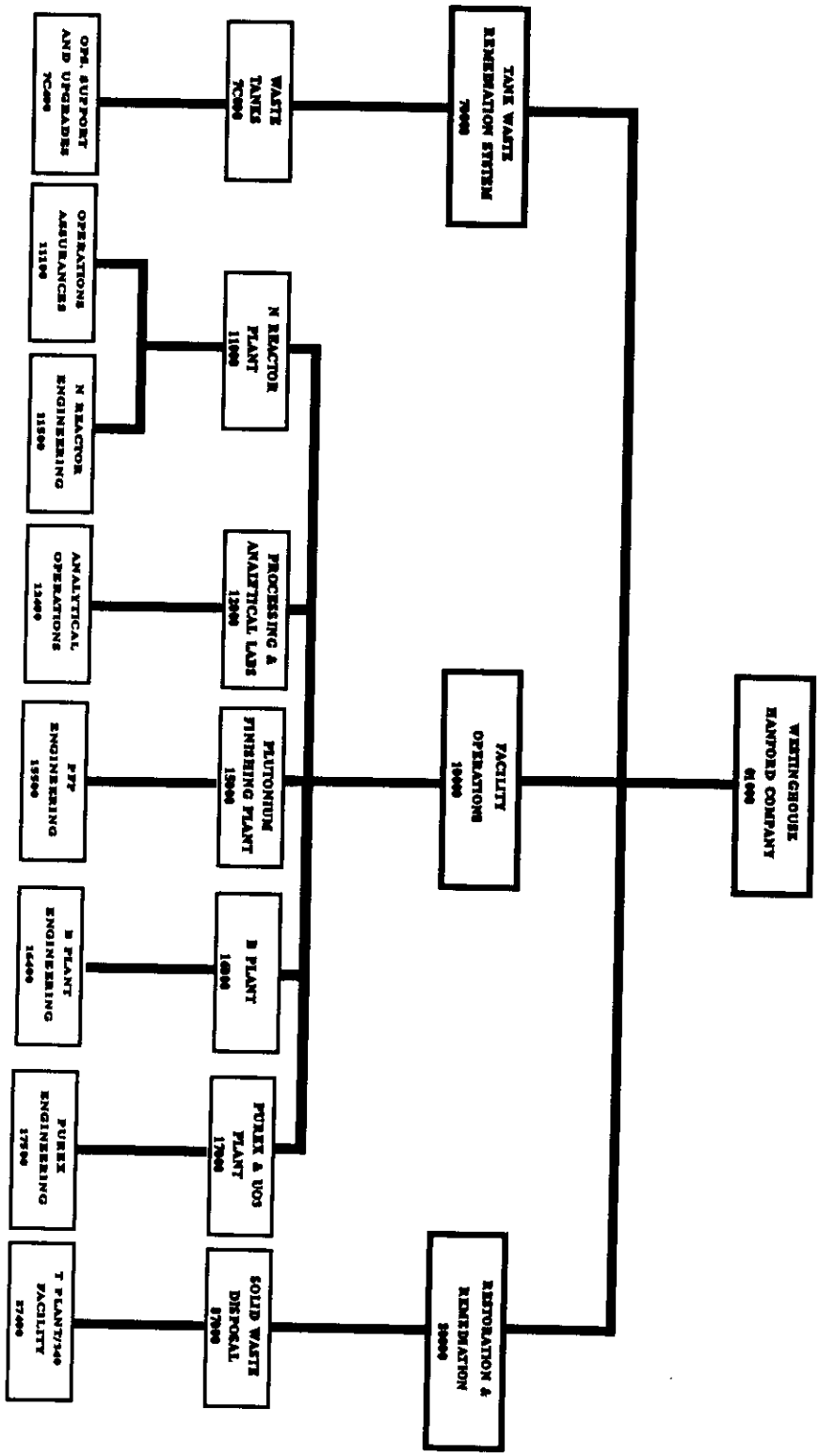

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Figure 7. Organizational Chart for Operations Support Services.

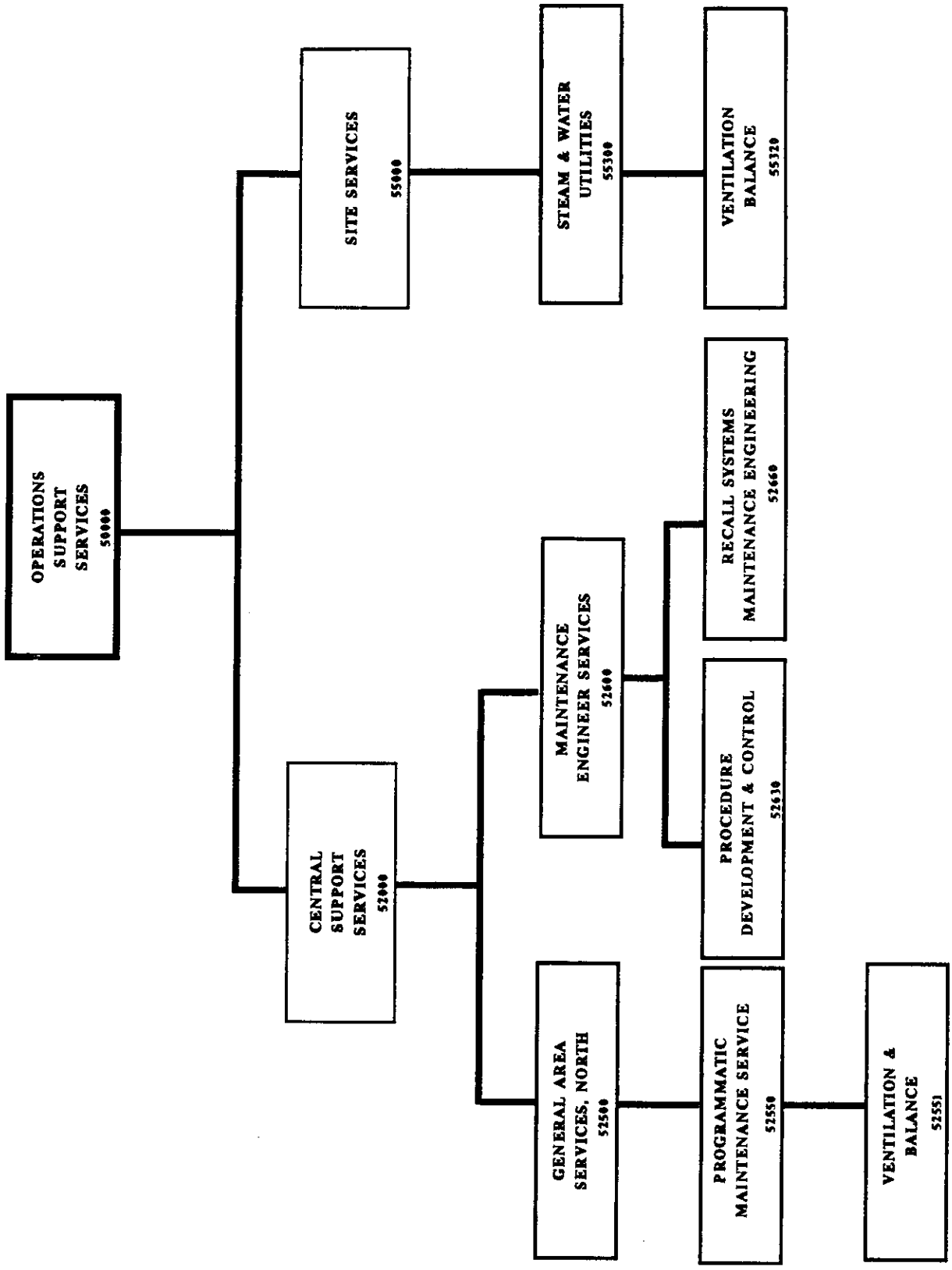

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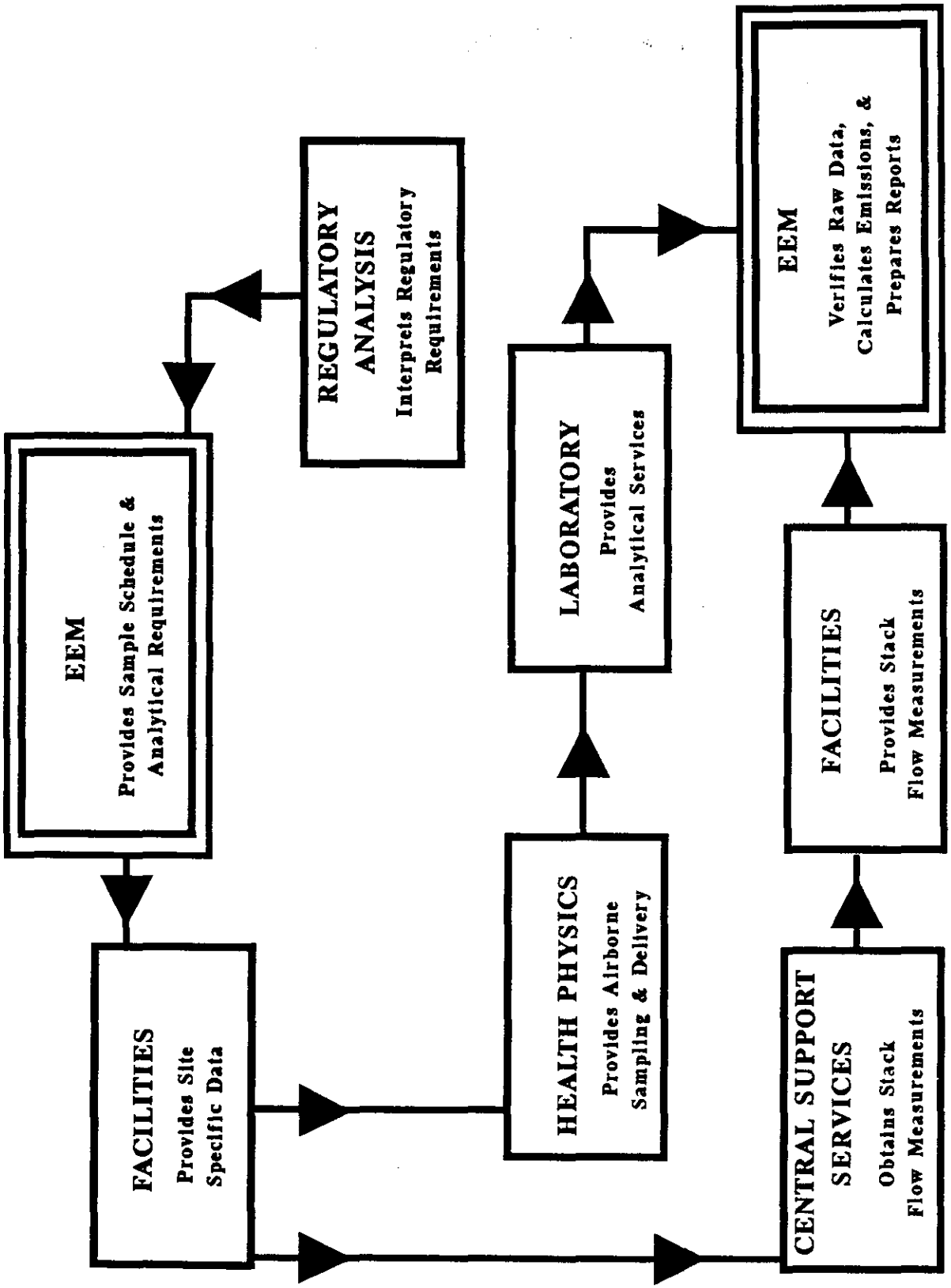
Figure 8. Emission Sampling and Analytical Implementation.



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8.0 PERFORMANCE AND SYSTEM AUDITS

Audits shall be performed to verify the quality of operation of one or more elements of the total measurement system. Audits will be of the two types below.

- Performance audits, in which quantitative data are independently obtained for comparison with data routinely obtained by the measurement system.

- System audits, involving a qualitative onsite evaluation of laboratories (or other organizational elements of the measurement system) for compliance with established QA program and procedure requirements. This also includes audits of individual facility sampling programs against those requirements of this QAPP and facility QAPjPs.

A performance audit system needs to be established whereby performance evaluation samples are submitted to the laboratories.

System audits are currently being performed by the Environmental Compliance Assurance and the Quality Compliance Assurance Organizations. (See Sections 4.2 and 4.2.1 of this document).

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9.0 CORRECTIVE ACTION

Corrective action requests required as a result of surveillance or audit activity shall be documented and dispositioned as required by WHC-CM-4-2, QI 10.4, "Surveillance;" QR 15.0, "Control of Nonconforming Items;" QI 15.1, "Nonconforming Item Reporting;" and/or QR 16.0 "Corrective Action" (WHC 1988).

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10.0 QUALITY ASSURANCE REPORTS

As stated in Sections 3.0 and 8.0, radionuclide effluent monitoring shall be regularly assessed by surveillance and auditing processes. Surveillance, nonconformance, audit, and corrective action documentation shall be considered QA records and shall be documented and dispositioned as stated in Section 4.0. Records management requirements applicable to subcontractors or participant contractors shall be defined in applicable procurement documents or work orders as noted in Section 6.2.8.

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11.0 REFERENCES

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*, Vol. 2, "Calendar Year 1990 Annual Update," Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 1991, *Hanford Federal Facility Agreement and Consent Order*, Vol. 1, "Second Amendment September 1991," Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA, 1983, *Guidelines and Specifications for Preparation of Quality Assurance Program Plans*, QAMS 004/80, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, U.S. Environmental Protection Agency, Washington, D.C.

WHC, 1988, *Quality Assurance Manual*, WHC-CM-4-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1989a, *Environmental Compliance Verification Manual*, WHC-CM-7-6, Westinghouse Hanford Company, Richland, Washington.

WHC, 1989b, *Job Control System Manual*, WHC-CM-8-8, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990a, *Organization Charts and Charters*, WHC-CM-1-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990b, *Management Requirements and Procedures*, WHC-CM-1-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990c, *Operations Support Services Standard Practices*, WHC-CM-8-10, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Health Physics Procedures*, WHC-IP-0692, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *200 Area Support Services*, WHC-CM-8-2, Westinghouse Hanford Company, Richland, Washington.

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APPENDICES TO THE QUALITY ASSURANCE PROGRAM PLAN

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INTRODUCTION TO APPENDICES

These appendices supply information regarding a point-by-point comparison with Title 40, *Code of Federal Regulations* (CFR), Part 61*, Appendix B, Method 114, for the Hanford Site air emissions involving stacks known to have the potential to exceed 40 CFR 61, Subpart H, limits. Please note that Appendices A through F are intended to supply the information for which each facility has responsibility, and that Appendices G and H are intended to supply the information for which the analytical laboratories have responsibility. Specifically, Appendix G includes information for Hanford Site 200 Area stack analyses, and Appendix H includes information for Hanford Site 300 Area stack analyses.

*EPA, 1992, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, U.S. Environmental Protection Agency, Washington, D.C.

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APPENDIX A

METHOD 114 COMPARISON FOR STACK 291-A-1

Dan Johnson/Jahan Lohrasbi

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APPENDIX A

METHOD 114 COMPARISON FOR STACK 291-A-1

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

Particulates are collected on a sample filter made of Gelman Versapor 3000*. According to the manufacturer, this filter medium has an efficiency of 95.8% for 0.3 μm particles.

2.2.1 The Radionuclide Tritium (H-3). Tritium in the form of water vapor is collected from the extracted effluent sample by sorption, condensation or dissolution techniques. Appropriate collectors may include silica gel, molecular sieves, and ethylene glycol or water bubblers.

Tritium in the gaseous form may be measured directly in the sample stream using Method B-1, collected as a gas sample or may be oxidized using a metal catalyst to tritiated water and collected as described above.

No irradiated fuel has been introduced into the Plutonium-Uranium Extraction (PUREX) Plant for several years. No dissolutions have been performed since late 1989. Gaseous sampling systems have shown that the levels of ^{3}H and ^{14}C have fallen to levels at or below the analytical detection limit, which were well below environmental release and monitoring limits. Consequently, sampling for these nuclides is no longer required or performed.

2.2.2 Radionuclides of iodine. Iodine is collected from an extracted sample by sorption or dissolution techniques. Appropriate collectors may include charcoal, impregnated charcoal, metal zeolite and caustic solutions.

No irradiated fuel has been introduced into the PUREX Plant for several years. No dissolutions have been performed since late 1989. Furthermore, concentrations of radioiodine in any fuel available for processing have decayed to such a low level that there is no longer any requirement to monitor for iodine. Nevertheless, sampling for iodine continues. Because it is not required, this sampling may be discontinued without notice.

After flowing through the Gelman Versapor 3000 filter, the gas sample flows through two silver zeolite cartridges to capture iodine.

2.2.3 Radionuclides of Argon, Krypton and Xenon. Radionuclides of these elements are either measured directly by an in-line or off-line monitor, or are collected from the extracted sample by low temperature sorption techniques, Appropriate sorbers may include charcoal or metal zeolite.

*Trademark of Gelman Sciences, Inc.

No irradiated fuel has been introduced into the PUREX Plant for several years. No dissolutions have been performed since late 1989. Gaseous sampling systems had shown that the levels of ^{3}H and ^{14}C had fallen to levels at or below the analytical detection limit, which were well below environmental release and monitoring limits. Consequently, sampling for these nuclides is no longer required or performed. The release of other radioactive gases decreased more rapidly than for these nuclides. Consequently, there is no need for gaseous nuclide sampling.

2.2.4 Radionuclides of Oxygen, Carbon, Nitrogen and Radon. Radionuclides of these elements are measured directly using an in-line or off-line monitor. Radionuclides of carbon in the form of carbon dioxide may be collected by dissolution in caustic solutions.

There is no longer need for gaseous radionuclide sampling (see Sections 2.2.1 through 2.2.3 above.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 Documentation identifying the organizational structure, functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program.

See Section 6.2 of the main part of this document for the organizational structure.

4.2 Prescribed administrative controls to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-12 (WHC 1992a), Section 1.14, REV 1, ALARM RESPONSE AND MANAGEMENT. This practice establishes requirements and provides guidance for responding to alarms that are the responsibility of Health Physics (HP).

This practice does not apply to alarms intentionally activated according to approved procedures, (e.g., functional test, source test). Facility specific procedures or desk instructions based on those procedures may be provided by the Area HP Managers to address alarm systems specific to each facility.

WHC-CM-4-12, Section 2.1, REV 0, RADIOLOGICAL PROBLEM REPORTING PROGRAM. The purpose of the Radiological Problem Report (RPR) program is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1 EMERGENCY RESPONSE. An EMERGENCY is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To be able to perform this function HP personnel receive training to respond to a variety of emergency situations. The HP procedures are written to provide guidelines to respond to emergencies. Together, the training and written procedure detail the HP Emergency Response Program.

Emergency Response. The HP personnel are, in many situations, the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by personnel observing the event, alarms, the Patrol Operation Center, or the Emergency Control Center(s) once they are manned. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person such as fire or patrol. A rapid response is required; however, no undue risks should be taken nor should employee personnel safety be compromised. The type of emergency determines the level of planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route, etc.) and approval of the Building/Facility Emergency Director is necessary for a re-entry.

Although HP personnel respond to an emergency using basic guidelines, an area/facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692 (WHC 1991a), Section 12.1.2.3, REV 2, EFFLUENT EXHAUST CAM ALARM RESPONSE. This procedure establishes the standard method of handling samples from, and response to alarms at, Effluent Exhaust CAM systems.

WHC-IP-0692, Section 12.1.2.4, REV 0, PUREX MAIN STACK (291-A-1) ALARM RESPONSE. This procedure establishes the method of response to alarms occurring on the Moving Filter Radioactive Aerosol Monitor (MFRAM), on the Continuous Particulate Release Monitor (CPRM), to alarms on the CPRM or MFRAM iodine monitors, or to high-activity levels detected on the Effluent Release Record Sample.

WHC-IP-0692, Section 12.1.6, REV 2, STACK EFFLUENT RELEASE RESPONSE. This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks.

WHC-IP-0692, Section 12.2.1, REV 2, EMERGENCY RESPONSE AIR SAMPLING. This procedure establishes the instruction and guidelines for air sampling in an emergency situation.

WHC-IP-0692, Section 12.2.3, REV 0, HEALTH PHYSICS EMERGENCY RESPONSE TEAM. This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team and the Radiation Protection Technologist (RPT) Field Survey Teams.

WHC-IP-0692, Section 12.2.4, REV 2, EMERGENCY RADIOACTIVE PLUME TRACKING. This procedure establishes the instruction to track a plume created from a radioactive material release to the environment.

WHC-IP-0692, Section 12.2.6, REV 0, GENERAL GUIDELINES FOR EMERGENCY RESPONSE. This procedure provides general guidelines to handle emergency situations.

WHC-IP-0263-202A (WHC 1992b), *Westinghouse Hanford Company Emergency Plan for PUREX Facility*. This document provides instructions for many types of emergencies, including excessive releases of radioactivity via the stacks.

WHC-CM-5-9 (WHC 1992c), Section 2.3, REV 1, PUREX/UO_3 Plant Occurrence Categorization, Notification, and Reporting. This procedure provides instructions for notification and reporting of specific events including environmental releases and related events.

4.3 A description of the sample collection and analysis procedures used in measuring the emission, including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rational for site selection.

The 291-A-1 stack is 7 feet in diameter. The record sampling site is a vertical section of the stack, at a height of 60 feet above-grade. There are a total of three sampling sites and six sampling probes.

The elevations of the sample ports are 60, 74, and 88 feet above-grade, which is the location of the last major flow disturbance in the stack. The sample ports are, therefore, approximately 8.6, 10.6, and 12.6 diameters downstream of the last major disturbance.

The stack is 200 feet, or 28.6 diameters, tall. The sample ports are, therefore, approximately 20, 18, and 16 diameters upstream of the next major flow disturbance.

The sites were chosen to provide representative sampling of the effluent and to comply with ANSI N13.1-1969 (ANSI 1969). The lowest sample port was chosen as the location of the record sample probe to minimize the length of sample line in accordance with ANSI N13.1-1969. These sample points also meet the criteria of 40 CFR 60, Appendix A, Method 1 (EPA 1992).

4.3.2 A description of the sampling probes and representativeness of the samples.

The sampling probes are "rakes," that is, multiport probes. The rakes are paired, i.e., there are two rakes at each sample location. With the exception of the particulate record sample, each rake has six inlet ports consisting of 3/8 in. OD by 0.035 in. wall 316 stainless steel tubing. At the inlet, each port is tapered to a knife edge with a 15-degree angle. At the 74-foot level, the inlet ports have a 2-in. vertical section followed by a 2-in. radius bend leading into the rake. (The backup record sample is collected from a rake at the 74-foot level.) At the 60-foot and 88-foot levels, the inlet ports have a 1-7/8-in. vertical section followed by a 1-7/8-in. radius bend.

The six-point sample rakes collect samples from the approximate centers of equal-area annuli in the stack, alternating between the near and far sides of the annuli. (For an annulus, the "center" is halfway between the inner and outer radii of an annulus.) The table

below compares the actual and ideal locations of the inlet ports, and also lists the difference in inches. The positions are measured from the center of the stack in the direction away from the liner penetration. The tolerance on the actual dimensions is ±0.1 in.

Actual (feet)	Ideal (feet)	Difference (inches)
-3.33333	-3.34752	0.170289
-2.66666	-2.66630	0.004329
-1.66666	-1.72479	0.697569
0	0	0
2.25	2.247799	0.026401
3	3.026393	0.316717

The rake that currently collects the particulate record sample has 16 inlets, consisting of 304 stainless steel tubing. At the inlet, each port is tapered to a knife edge with a 15-degree angle. The inlet ports have a 2-in. vertical section followed by a 2-in. radius bend leading into the rake at a 45-degree angle. The outer two ports are made of 3/8 in. OD, 0.065-in. wall tube. The next six ports are made of 1/4 in. OD, 0.028-in. wall tube. The inner eight ports are made of 1/4 in. OD, 0.035-in. wall tube. The inlet ports are arranged symmetrically and approximately centered over equal-area semi-annuli. The table compares the actual and ideal locations of the inlet ports, and also lists the difference. The positions are measured from the center of the stack. The tolerance on the actual dimensions is ±0.1 in.

Actual (feet)	Ideal (feet)	Difference (inches)
0.6167	0.618718	0.024621
1.5000	1.493718	0.075378
1.9500	1.946652	0.040178
2.3083	2.309088	0.009063
2.6250	2.620933	0.048799
2.9000	2.899040	0.011508
3.1500	3.152519	0.030234
3.3833	3.386975	0.043701

The use of an isokinetic 16-point probe located more than 8 duct diameters downstream of the last major flow disturbance ensures representative sampling.

4.3.3 A description of any continuous monitoring systems used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable--emissions are not monitored continuously for compliance demonstration.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The sample is continuously removed from the effluent stream via the rake described in Section 4.3.2. The sample then flows through the sample line and the particulates are collected on a sample filter. The sample filters are replaced weekly, and sometimes more often. The filtered gas then flows through two silver zeolite cartridges to capture iodine and other volatile elements. Section 4.3.6 describes the calibration of the sample flow rate measurement equipment.

No irradiated fuel has been introduced into the PUREX Plant for several years. No dissolutions have been performed since late 1989. Gaseous sampling systems had shown that the levels of ^{3}H and ^{14}C had fallen to levels at or below the analytical detection limit, which were well below environmental release and monitoring limits. Consequently, sampling for these nuclides is no longer required or performed. The release of other radioactive gases decreased more rapidly than for these nuclides. Consequently, there is no need for gaseous nuclide sampling.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis, calibration procedures and frequency of calibration.

The *Facility Effluent Monitoring Plan Determination for the 200 Area Facilities* (WHC 1991b) lists the analytes of interest for the 291-A-1 Stack. These are: ^{238}Pu, $^{239,240}Pu$, ^{241}Am, $^{89,90}Sr$, Gamma Energy Analysis, ^{147}Pm, ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. For a description of the laboratory analysis procedures for these analytes, see Appendix G.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

After exiting the record sample filter, the air flows through a flow measurement and control system. Currently a Kurz* Model 505 system measures the sample flow rate, a Kurz model 101-RM totalizes the sample flow, and a Kurz 710RMD(4200) adjusts a control valve to maintain a constant flow. At least once a day an employee adjusts the 710RMD to ensure isokinesis. The instruments are calibrated at least once per year (normally every 6 months). Currently the calibration procedures are PSCP-1-045, PSCP-4-167, and PSCP-4-197. After exiting the flow control valve, the air flows through a rotameter which provides backup indication. Approximately yearly calibration is accomplished by comparison with a standard rotameter, using procedure PSCP-7-001.

4.3.7 A description of effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

A six-point Kurz probe continuously measures the flow through the stack at the 74-foot level. A Kurz Model 195B transmitter sends the signal to a Kurz Model 142-RMD and a Kurz Model 132, which then drives a recorder, which continuously records the flow rate. The

*Kurz is a trademark of Kurz Instruments, Inc.

total flow is recorded on a digital integrator, or can alternately be summed from the recorder trace. The six flow elements on the six-point probe are pre-calibrated by the manufacturer. The remaining instruments are calibrated at least once per year (normally every 6 months). Currently the calibration procedures are PSCP-1-044, PSCP-4-001, and PSCP-4-167.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy, and completeness of the emission measurement data including a description of the procedures used to assess these parameters.

See Appendix G.

4.5 The quality control program shall evaluate and track the quality of the emission measurement data against preset criteria. The program should include, where applicable, a system of replicates; spiked samples; split samples; blanks; and control charts. The number and frequency of such quality control checks shall be identified.

See Appendix G.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sampling collection, analysis, and reporting system. Sample handling and preservation procedures shall be established to maintain integrity of the samples during collection, storage, and analysis.

Refer to Section 6.2.3 of the main part of this document.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Refer to Section 7.0 of the main part of this document.

4.8 A corrective action program shall be established including criteria for when corrective actions will be taken and who is responsible for taking the corrective action.

Refer to Sections 4.0 and 7.0 of the main part of this document.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emission measurements program. These reports should include assessment of the quality of the data, results of audits, and description of corrective actions.

Refer to Section 9.0 of the main part of this document.

4.10 Provide qualifications and training needed for Facility Cognizant Engineer.

WHC-CM-5-9, Section 2.19, REV 0, SELECTION OF PUREX/UO_3 COGNIZANT ENGINEERS AND COGNIZANT ENGINEER MANAGERS. This procedure establishes the requirements, qualifications, and process for the selection of PUREX/UO_3 Cognizant Engineers and Cognizant Engineer Managers.

REFERENCES

ANSI, 1969, *Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility*, ANSI N13.1, American National Standards Institute, Washington, D.C.

EPA, 1992, "Standards of Performance for New Stationary Sources," Title 40, *Code of Federal Regulations*, Part 60, U.S. Environmental Protection Agency, Washington, D.C.

PSCP-7-001, *AIR ROTAMETER, CALIBRATION PROCEDURE*

PSCP-4-197, *KURZ MODEL 710 RMD FLOW CONTROLLER, 4200 AND 7500 SYSTEMS*

PSCP-4-167, *KURZ SAMPLE LOW TOTALIZER, MODEL 101*

PSCP-4-001, *TAYLOR QUICK-SCAN RECORDER, SERIES 1300, CALIBRATION PROCEDURE*

PSCP-1-045, *KURZ LINEAR MASS FLOW METER, SERIES 505 AT PUREX*

PSCP-1-044, *KURZ 142/151 RM, CALIBRATION PROCEDURE*

WHC, 1991a, *Health Physics Procedures Manual*, as amended, WHC-IP-0692, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Facility Effluent Monitoring Plan Determination for the 200 Area Facilities*, WHC-EP-0440, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992a, *Health Physics Practices Manual*, as amended, WHC-CM-4-12, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992b, *Westinghouse Hanford Company Emergency Plan for PUREX Facility*, WHC-IP-0263-202A, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992c, *PUREX/UO_3 Plant Occurrence Categorization, Notification, and Reporting*, as amended, WHC-CM-5-9, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX B

METHOD 114 COMPARISON FOR STACK 291-B-1

J. A. Koerner

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APPENDIX B

METHOD 114 COMPARISON FOR STACK 291-B-1

This section provides a line-by-line evaluation of quality assurance method requirements outlined in 40 CFR 61, Appendix B, Method 114, as they apply to the 291-B-1 stack at the B Plant, Hanford Site.

1.0 Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

No response required.

2.0 Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see Section 61.18).

The Gelman Versapor 3000 filter medium is an acrylic copolymer membrane supported by a non-woven nylon fabric. The manufacturer rates the efficiency of this medium at 91 percent for 0.3-μm aerosol. The manufacturer recently tested 24 samples with a 0.3-μm di-octyl phthalate aerosol per ASTM D 2986-71. The measured average efficiency was 95.8 percent and the standard deviation was 1.6 percent, which supports the rated efficiency.

2.2 Radionuclides as Gases.

The 291-B-1 Stack does not exhaust radionuclide gases; therefore, this section is not applicable to this stack (WHC 1991a).

2.3 Definition of Terms

3.0 Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are described which are applicable to the analysis of radionuclides collected from airborne effluent streams at stationary sources. These methods are applicable only under the conditions stated and within the limitations described. Some methods specify that only a single radionuclide be present in the sample or the chemically separated sample. This condition should be interpreted to mean that no other radionuclides are present in quantities which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining the activity of any alpha-emitting radionuclide, regardless of what other radionuclides are present in the sample provided the chemical separation step produces a very thin sample and removes all other radionuclides which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

The 222-S Laboratory method involves dissolution (LA-549-112), chemical separation (LA-943-123), electrodeposition (LA-542-101), followed by alpha spectrometry (LA-508-051) (WHC 1992b). It meets all the requirements of the EPA-suggested method. This is used for analyzing ^{241}Am, ^{238}Pu, and $^{239,240}Pu$ in the air filter samples. The activities of these radionuclides are determined by direct comparison with the recoveries of (National Institute of Standards and Technology [NIST] traceable) ^{243}Am and ^{236}Pu tracers.

3.1.2 Method A-2, Radiochemistry-Alpha Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It may also be applicable for determining compliance, when other radionuclides of the separated element are present, provided that the calculated emission rate is assigned to the radionuclide which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

Because the tracer technique is used in the separation process, this method is not used for air filter analysis.

3.1.3 Method A-3, Direct Alpha Spectrometry.

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM) or better, ASTM-D-3084(16).

The 222-S Laboratory method follows the procedure LO-150-133, then LA-508-110 for total alpha counts, and finally LA-508-051 for alpha spectrometry (WHC 1992b). It partially meets the requirements of the EPA method. This method is usually used for emergency air samples. The sample is counted on the alpha counter of known efficiency to obtain the total alpha counts. In the alpha energy analysis (AEA), the relative peak fractions of different alpha emitters identified in the sample are determined. The peak fractions are then used to correct the total alpha counts and thus determine the activities of individual alpha radionuclides present in the sample.

3.1.4 Method A-4, Direct Alpha Counting (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determination may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, or the identity and isotopic ratio of the radionuclides in the sample are well known, and (2) measurements using either Method A-1, A-2 or A-5 have shown that this method provides a reasonably accurate measurement of the emission rate. Gross alpha measurements are applicable to unidentified mixtures of radionuclides only for the purposes and under the conditions described in Section 3.7. APHA-601(3), ASTM-D-1943(10).

The 222-S Laboratory method follows procedure LA-508-110 or LA-508-114. It meets all of the requirements stated in Method A-4.

3.1.5 Method A-5, Chemical Determination of Uranium.

Uranium: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E318(15), ASTM-D-2907(14).

Total uranium is determined by procedure LA-925-107. The laser-induced kinetic phosphorescence analyzer is an improvement over the old fluorometric method for uranium determination. It is highly sensitive (lower detection level

of 50 parts per trillion is quite possible) because the laser frequency is used specifically for excitation of uranium atoms. It is faster and produces more reliable results. Quality can also be monitored during analysis. It exceeds the requirements in Method A-5.

3.1.6 Method A-6, Radon-222-Continuous Gas Monitor.

Principle: Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

Applicability: This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

Not applicable at the 222-S Laboratory; direct monitoring of ^{222}Rn is not performed at the 222-S Laboratory.

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

Principle: Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is corrected to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

Applicability: Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon 220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

Not applicable; direct monitoring of ^{222}Rn is not performed at the 222-S Laboratory.

3.2 Methods for Gaseous Beta Emitting Radionuclides.

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for measuring the activity of a gaseous beta emitting radionuclide in an effluent stream that is suitable as a counting gas, when no other beta-emitting nuclides are present. DOE/EP-0096(17), NCRP-58(23).

Not applicable; not performed.

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

Principle: The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

Applicability: This method is applicable only to radionuclides with maximum beta particle energies greater then 0.2 MeV. This method may be used to measure emissions of specific radionuclides only when it is known that the sample contains only a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. Specific radionuclide analysis of periodic grab samples may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in Section 3.7.

Not applicable; not performed.

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides.

3.3.1 Method B-3, Radiochemistry-Beta Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for measuring the activity of any beta-emitting radionuclide, with a maximum energy greater than 0.2 MeV, provided no other radionuclide is present in the separated sample. APHA-608(5).

The method for determining ^{89}Sr, $^{90}Sr/^{90}Y$ in air filter samples is carried out using procedures LA-549-112 (dissolution) and LA-220-103 (for chemical separation), followed by procedure LA-508-111 (total beta counting). The laboratory method certainly meets the requirements stated above.

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: Gross beta measurements are applicable only to radionuclides with maximum beta particle energies greater than 0.2 MeV. Gross beta measurements may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, and (2) measurements made using Method B-3 show reasonable agreement with the gross beta measurement. Gross beta measurements are applicable to mixtures of radionuclides only for the purposes and under the conditions described in Section 3.7. APHA-602(4), ASTM-D-1890(11).

For gross beta determination, procedure LA-508-110 or LA-508-114 is followed. It satisfies the Method B-4 requirements.

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to any beta-emitting nuclide when no other radionuclide is present in the sample or the separated sample provided that it can be incorporated in the scintillation cocktail. This method is also applicable for samples which contain more than one radionuclide but only when the energies of the beta particles are sufficiently separated so that they can be resolved by the spectrometer. This method is most applicable to the measurement of low-energy beta emitters such as tritium and carbon-14. APHA.609(6), EML LV-539-17(19).

This method is used for determining ^{147}Pm in air filter samples (LA-549-112 for dissolution, LA-613-111 for chemical separation, LA-548-111 for incorporating into scintillation cocktail, and LA-508-121 for liquid scintillation counting). This is also used for determination of ^{14}C (LA-348-101, LA-548-111, and LA-508-121, sequentially) and ^{3}H (LA-218-112, LA-548-111, and LA-508-121, sequentially) in gas samples. This method satisfies all of the requirements.

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1. High Resolution Gamma Spectrometry.

Principle: The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radio-chemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It can be applied to complex mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gases. The method may also be applied to the analysis of gaseous gamma emitting radionuclides directly in an effluent stream by passing the stream through a chamber or cell containing the detector. ASTM-3649(9), IDO-12096(18).

The 222-S Laboratory method uses gamma ray spectroscopy with high-resolution germanium detectors and follows procedure LA-508-052. It meets all the requirements explained in Method G-1.

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 keV. It can be applied only to relatively simple mixtures of gamma emitting radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

Not applicable, because this method is not used in air filter analysis.

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It is not applicable to mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector.

Not applicable, because this technique is not used in air filter analysis.

3.4.4 Method G-4, Gross Gamma Counting.

Principle: The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

Applicability: Gross gamma measurements may be used to measure emissions of specific radionuclides only when it is known that the sample contains a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This method may be applied to analysis of gaseous radionuclides directly in an effluent stream by placing the detector directly in or adjacent to the effluent stream or passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

Not applicable.

3.5 Counting Methods. All of the methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

- Gas Flow Proportional Counters. The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

- Scintillation Counters. The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

- Solid-State Counters. Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

- Alpha Spectrometers. Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

Alpha proportional counters (home-built chambers with EG&G ORTEC electronics), window-type gas flow proportional counters (some having automatic sample changer), surface-barrier solid-state detectors connected to a multichannel analyzer (MCA) (Series 85, Jupiter system manufactured by Canberra Industries, Inc.) are used for air filter analysis in the 222-S Laboratory. Laboratory equipment meets the specifications for alpha counting.

3.5.2 Beta Counting:

- Ionization Chambers. These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

- Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters. The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

- Counters. The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

- Liquid Scintillation Spectrometers. Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

Window-type gas flow proportional counter (some having an automatic sample changer) liquid scintillation spectrometers manufactured by Beckman Instruments, Inc. are used for analysis. The 222-S Laboratory counting equipment meets the requirements specified above for beta counting.

3.5.3 Gamma Counting:

- Low-Resolution Gamma Spectrometers. The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

- High-Resolution gamma Spectrometers. Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

- Single Channel Analyzers. Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

High-resolution gamma detectors (high-purity germanium [HPGe] detectors for both low and high energies) from EG&G ORTEC and Princeton Gamma Tech and well-type pure Ge detectors connected to MCA (Canberra's Jupiter system) are available and used for air filter analysis. Our equipment exceeds the requirements for gamma counting specified above.

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

A mixed gamma standard (NIST traceable) emitting various gamma-rays ranging from 59 to 1,850 keV is used, using vendor-supplied calibration software, for constructing efficiency versus energy calibration curves for different geometrical configurations used in gamma analysis. The calibration procedure for gamma ray spectrometer is documented in LQ-508-003. Our calibration procedure meets the EPA criteria for gamma ray spectroscopic analysis.

For calibration of beta detectors for $^{90}Sr/^{90}Y$ analysis, procedure LQ-508-002 is used in conjunction with LQ-508-005. It meets the requirements of the method specified above. A method standard also is used to check the performance and calibration of the detector.

For calibration of alpha-beta proportional counters, the procedure LQ-508-002 is carried out. It partially deviates from the EPA requirements. For gross alpha and gross beta measurements, our instruments are calibrated with ^{241}Am and ^{60}Co standards, respectively. The reasons for choosing the ^{241}Am standard for alpha calibration are as follows:

- **It is commonly found in the main stack air samples**
- **Alpha counting efficiency usually is the same for other alpha emitters that also are found in the air stack samples**
- **The ^{241}Am standard also can be checked independently by gamma analysis.**

The reason for using the ^{60}Co standard for beta calibration is the lower counting efficiency with ^{60}Co (beta max = 317 keV) compared to those with ^{137}Cs (beta max = 511 keV) and ^{90}Sr (beta max = 546 keV). Consequently, it will generate conservative numbers in our analyses.

The calibration curves relating weight of solids present to counting efficiencies are not done in alpha-beta analysis, but currently are being evaluated.

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which have the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in Section 3.1 through 3.4 may be used.

The air samples from the main stacks are well characterized. Some of the radionuclides identified (^{241}Am, ^{238}Pu, $^{239,240}Pu$, ^{90}Sr, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{14}C, ^{3}H, and ^{131}I) are listed in Table 1 of Method 114 (EPA 1991) and are analyzed according to the approved methods given in the table. Other radionuclides (^{95}Nb, ^{95}Zr, ^{129}I, $^{106}Rh/^{106}Ru$, ^{113}Sn, ^{125}Sb, and ^{103}Ru) not listed in the table are analyzed by the methods outlined in Method 114, depending on the type of emitted radiation. It is important to note here that the radionuclides ^{95}Zr, ^{95}Nb, and ^{103}Ru have nearly decayed to nondetectable levels because no product is being produced.

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

This is not applicable, because the air effluents from the Hanford Site main stacks are well characterized. However, gross alpha and beta analyses for weekly and daily air samples are routinely performed in the 222-S Laboratory before starting specific radionuclide analyses. Following this practice, the facility can verify a significant release of a radionuclide into the air so corrective actions to minimize radionuclide emission into the environment can be taken promptly by facility personnel. The gross alpha and beta results from analysis are compared to those listed in the appendix of DOE Order 5400.5 (DOE 1990) for compliance.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

For the organizational structure, refer to Section 6.2 of WHC-EP-0536.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-1, REV 1, *Emergency Plan* (WHC 1992c). This manual contains an emergency preparedness plan to protect onsite personnel, public health and safety, and the environment in the event of operation, natural phenomena, and/or safeguards and security events at Hanford Site Facilities. The requirements stated in the emergency preparedness plan are implemented through subtier plans and implementing procedures. These implementing plans and procedures established for response to emergencies by Hanford Site personnel and emergency management organizations are contained in WHC-CM-4-43, *Emergency Management Procedures*; WHC-CM-4-44, *Emergency Preparedness Administrative Manual*; various building emergency plans; and Hanford Site Facility operating procedures (WHC-IP-0263-BPC) (WHC 1992a).

WHC-CM-4-12, Section 1.14, REV 0 (WHC 1992c), "Alarm Response and Management." This section provides guidance and sets requirements for managing the responses to alarms that are the responsibility of Occupational Health and Safety (OHS). This practice is applicable to all members of the OHS. Area OHS managers shall ensure that all members of their organizations are aware of and adhere to this practice.

WHC-CM-4-12, Section 2.1, REV 0, "Radiological Problem Reporting Program." The purpose of this section is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1, "Emergency Response." An emergency is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To be able to perform this function, HP personnel receive training to respond to a variety of emergency situations. The HP procedures (WHC-IP-0692 [WHC 1991b] and WHC-CM-4-12) are written to provide guidelines to respond to emergencies. Together, the training and the written procedures detail the HP emergency response program.

The HP personnel, in many situations, are the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel use their training and experience to make decisions during the initial response to an emergency.

An emergency response may be initiated by (1) personnel observing the event, (2) alarms, (3) the Patrol Operation Center, or (4) the Emergency Control Center(s) once they are manned. The type of emergency determines the level of planning for HP response. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person, such as a

firefighter or patrol. If a rapid response is required, no undue risks should be taken nor should personnel safety be compromised. When an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route) and approval of the Building or Facility Emergency Director is necessary to re-enter.

Although HP personnel respond to an emergency using basic guidelines, an area or facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 5.2.2.6, REV 2, "Gaseous Effluent Sampling and Monitoring System Operability Inspection." This procedure establishes the method of inspection, evaluation, and discrepancy reporting of the operational status of Gaseous Effluent Monitoring Systems (Stack Packs) in use in the 200 East and West Areas.

WHC-IP-0692, Section 5.2.2.7, REV 2, "Operation of Gaseous Effluent Sampling and Monitoring Systems." This procedure establishes the standard method of operation of Gaseous Effluent Sampling and Monitoring Systems (Generic Stack Packs) in use in the 200 East and West Areas.

WHC-IP-0692, Procedure No. 12.1.2.3, REV 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to, alarms at effluent exhaust continuous air monitor systems in an expedited fashion.

WHC-IP-0263-BPC, REV 0, "Emergency Response Plans" (WHC 1992a). This procedure establishes guidelines for actions to be taken if B Plant discharges highly radioactive gaseous material.

WHC-IP-0692, Procedure No. 12.2.1, REV 2, "Emergency Response Air Sampling." This procedure describes the guidelines and steps for emergency air sampling inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team (ERT) and the HP Technicians Field Survey Teams. These teams may be requested to respond to an emergency when an environmental release of radioactive material may extend beyond the control of a facility or outside the Hanford Site boundaries. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, REV 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a beta-gamma plume created from a radioactive material release to the environment and determine if it is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instruction given in

WHC-CM-7-5, *Environmental Compliance Manual*, and WHC-IP-0263-BPC, *Building Emergency Plan for B Plant Complex*. The purpose of these manuals and sections is to establish and implement specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences at B Plant, as required by WHC-CM-1-3, MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

The 291-B-1 Stack has an ID of 6.5 feet at the probe location, approximately 50 feet from the base. (The ID ranges from 7 feet at that base of the stack, to 5 feet at the top, 200 feet above the base.) There are twelve nozzles for sampling at the probe location; six nozzles supply the record sampler and the remaining six nozzles supply the beta-gamma monitor. ANSI N13.1-1969 (Section A3.2) recommends a minimum of six nozzles on a stack the diameter of the 291-B-1 Stack (WHC 1991d).

The procedure in 40 CFR 61, Appendix A, Method 1, requires sampling to be performed at least eight stack diameters downstream and two diameters upstream of any flow disturbances. Eight stack diameters corresponds to 52 feet and two stack diameters corresponds to 13 feet, based on the 6.5-foot diameter at the sampling location. As shown in the drawings and documentation listed in WHC (1991d), the 291-B-1 Stack complies with this procedure (WHC 1991d).

4.3.2 A description of sampling probes and representativeness of the samples.

The sampling probe consists of twelve total nozzles, as shown on Drawing H-2-94159 (WHC 1991d). Six nozzle inlets are 0.348 ± 0.002 inches and the other six are 0.250 ± 0.002 inches in diameter. The stack flow is fully turbulent (Reynolds number approximately 6.8×10^5) and, as stated in Section A.3.3.2 of ANSI N13.1-1969, "... as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." Therefore, the probe assembly is nearly isokinetic, as it was designed (see Note 4, Drawing H-2-94159 [WHC 1991d]).

4.3.3 A description of any continuous monitoring systems used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable; emissions are not monitored continuously.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

Particulate radionuclides are collected with the record sampler, which uses 47-mm diameter filter paper. This filter is a membrane filter which collects 0.3-μm particles with a collection efficiency of 95.8 percent. Record samplers are removed weekly and the sampler runs continuously to ensure a representative sample (WHC 1991a).

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis calibration procedures and frequency of calibration.

Total alpha and total beta activity is determined by procedure LA-508-110 or LA-508-114 on weekly samples, and occasionally on daily air samples, per collection point. The calibration procedure is documented in LQ-508-002. It is done only when deemed necessary by a responsible scientist. The counting system is recalibrated only in case of (1) major repairs or adjustments to the power supply or detector or (2) calibration shift as indicated by the instrument control standards. The performance of the counting systems is checked by running the instrument control standards (^{147}Pm for low-energy beta, ^{60}Co for mid-energy beta, ^{137}Cs for high-energy beta, and ^{241}Am for alpha activity) separately. When a batch of air filter samples is run, all the performance standards and the background (for counting frequency refer to LA-150-115) also are run with it. To verify that the counting system is working properly, the standard values from analysis should fall within the administrative limits set according to appropriate quality assurance program plans (QAPP).

The 222-S Laboratory method for analysis of alpha emitters (^{241}Am, ^{238}Pu, and ^{239,240}Pu) involves various steps (LA-549-112 for dissolution, LA-943-123 for chemical separation, LA-542-101 for electrodeposition, and LA-508-051 for final alpha spectrometry). The analysis of alpha emitters is done on a quarterly composite of weekly and daily air filter samples. The energy resolution and calibration of the AEA system over the energy range of 4 to 6 MeV are checked once a month by the Preventive Maintenance Procedure 2S18006. Efficiency calibration of the AEA is not needed in our analysis method because direct comparison of the sample with recoveries of the tracers (^{243}Am and ^{236}Pu) is made to determine the activities of the radionuclides present in the sample. To carry out the sample analysis, AEA system performance is checked once every 24 hours for alpha energy shift with a certified mixed alpha source standard. Each alpha energy peak identified in the standard must fall within administratively assigned certain channels (+10) on the MCA. For counting frequency of performance check standards, procedure LA-150-115 is referred to. The recovery of the radionuclides and the calibration of the system are checked on a batch basis by running a method standard under the identical conditions as the sample.

The 222-S Laboratory method for determining beta activity (^{89}Sr, $^{90}Sr/^{90}Y$) consists of dissolution (LA-549-112), chemical separation (LA-220-103), and total beta counting (LA-508-111). Analysis is done on a quarterly composite of weekly and daily air filter samples per collection point. The calibration procedure LQ-508-002 (for a window-type gas flow proportional counter) is used in conjunction with procedure LQ-508-005 (for mother/daughter case, i.e., $^{90}Sr/^{90}Y$ in growth calibration). It is performed only when the responsible scientist finds it necessary. The reasons are the same as stated for total alpha and total beta. The performance of the counting system is checked once per shift by running instrument control standards (^{60}Co, ^{137}Cs, and ^{147}Pm for beta activity). The complete procedure for the $^{90}Sr/^{90}Y$ analysis in the sample is carried out with a method standard (several filter papers spiked with ^{90}Sr, ^{147}Pm, ^{60}Co, ^{241}Am, ^{239}Pu, and U) provided by the 222-SA Standard Laboratory on a batch basis. This checks the overall performance of our method. The chemical yield is determined by using the appropriate carrier.

Determination of beta activity (^{147}Pm, ^{14}C, and ^{3}H) involves processing (LA-549-112 and LA-613-111 for ^{147}Pm, LA-348-101 for ^{14}C, and LA-218-112 for ^{3}H), mounting in scintillation cocktail (LA-508-111), and finally, liquid scintillation counting (LA-508-121). The ^{147}Pm analysis is done on quarterly composites of weekly and daily air filter samples. The ^{14}C and ^{3}H analyses are done on biweekly gas samples. For calibration, the quality assurance (QA) section of procedure LA-508-121 is referenced. The calibration of the instrument is checked by the manufacturer's supplied sources (^{14}C and ^{3}H) and its software.

For ^{147}Pm analysis, the method standard is run once per quarter. The method standard is always run with a batch of samples for ^{3}H and ^{14}C analysis. The results of the method standard checks the overall performance, including the calibration of the counting system. The instrument calibration check is done a minimum of once a week (refer to LA-150-115).

For analysis of gamma emitters ^{95}Nb, ^{95}Zr, ^{134}Cs, ^{137}Cs, and ^{144}Ce the procedure LA-508-052 is followed. Analysis is done on quarterly composites of weekly and daily air filter samples. For analysis of volatile radionuclides (^{129}I, ^{131}I, $^{106}Rh/^{106}Ru$, ^{113}Sn, ^{125}Sb, and ^{103}Ru) collected weekly on silver zeolite cartridge, the procedure LA-288-101 is used in conjunction with procedure LA-508-052. Calibration of the gamma ray spectrometer is done with the procedure documented in LQ-508-003 using a (NIST traceable) certified mixed gamma ray standard. It is carried out only when it is deemed necessary by a responsible scientist. To check efficiency and energy calibration daily, the performance of each detector of the GEA system over the whole energy range is done once every shift by running a mixed gamma standard consisting of ^{241}Am for low energy, ^{137}Cs for mid energy, and ^{60}Co for high energy. The results of each of these radionuclides should fall within the

administrative limits set according to the appropriate QAPP to continue analysis of samples. The daily performance results are documented. Minor adjustments of the electronics (e.g., fine gain, pole zero of the amplifiers, lower level discriminator of analog-to-digital converter) are done from time to time when necessary for proper energy calibration. Whenever a minor electronic adjustment is done on a detector, it is followed by analysis of a performance standard. For a major shift in the calibration, the system is then thoroughly calibrated using LQ-508-003.

The content of the 222-S Laboratory's procedures, test plans, supporting documents, and drawings provide a sufficient level of detail to allow trained personnel to produce quality results safely. Laboratory procedures are controlled as required by WHC-CM-5-4, Section 5.4, "Analytical Laboratory Procedures." The specific content of laboratory procedures is defined by its author, based on accepted methods such as 40 CFR 61, Appendix B, Method 114 (EPA 1991). The content must be agreed to by the peer and technical reviewers. While authors are responsible for the specific content of their procedures, they address the topics below.

Summary--MANDATORY--A short description or abstract of the procedure containing enough information to distinguish it from other procedures.

Applications--MANDATORY--Defines the scope and purpose of the specific procedure. This section may be combined with the following element under the title "Applications and Limitations."

Limitations--MANDATORY--Briefly describes those areas in which the procedure is not applicable. A statement of accuracy and precision will be given where appropriate.

Quality Control (QC) Protocol--Procedures used to support environmental projects that have specific QC requirements. For these procedures, the source of the QC requirements will be identified. The samples or project that this element applies to will be identified. The following information is typical of QC requirements: frequency and type of calibration, reagent blank analysis, spike sample analysis, and duplicate sample analysis.

Impact Level Identifier--MANDATORY--An impact level will be identified for each procedure following WHC-CM-1-3, MRP 5.43, with a brief basis of determination statement. This MRP lists several descriptive paragraphs delineating what constitutes an Impact Level 1, 2, 3, or 4 activity. The following parts of MRP 5.43 cover most analytical laboratory procedures.

I. Section 5, paragraph 6, part c., Impact Level 3 -- Work authorization documentation associated with work involving occupational hazards not covered by approved procedure,

such as Operational Safety Assessments, Radiation Work Permits, or Industrial Safety Standards.

2. Section 5, paragraph 6, part c., Impact Level 4 -- Documentation for any activity not classed as Impact Level 1, 2, or 3.

The laboratories' procedures are usually specific to one activity. These activities are well defined using common scientific instrumentation and equipment operated in an acceptable manner. The chemicals and materials used are normally small quantities with limited potential for environmental or personnel safety impact. In general, the equipment used in the laboratory is not classified as Safety Class 3 or higher.

Safety--MANDATORY--The procedure must identify applicable safety hazards.

The following documents identify Hanford Site safety requirements:

- WHC-CM-4-3, *Volume 1-3, Industrial Safety*
- WHC-CM-4-10, *Radiation Protection*
- WHC-CM-4-15, *Radiation Work Requirements and Work Permits Manual*
- WHC-CM-4-29, *Nuclear Criticality Safety.*

Supporting document WHC-SD-CP-LB-003, *Safety in the Analytical Laboratory*, is the laboratory general safety document. The authors must review safety requirements and include safety warnings appropriate to the actions directed by the procedure.

Reagents--If the procedure requires analytical reagents, a list of reagents will be provided. The material safety data sheet number will be placed in brackets by each chemical name. Reagent makeup, storage container requirements, unique storage needs, shelf-life requirements, special labeling, and special preparation steps will be included. Special notations for any known or suspected carcinogen as listed on WHC-CM-4-3, Volume 2, Table 1, "WHC Master Carcinogen List," will be made on the reagent list.

Reagent preparation described fully in other current Hanford Site documentation may be included by reference.

Equipment--Special equipment needs will be listed. Standard hood or glovebox equipment is assumed to be available at the work station and does not need to be listed. The fabrication of off-standard equipment will be referenced or described in this section.

Procedure Steps--MANDATORY--A step-by-step description of operations necessary to perform the task will be presented in a logical and sequentially numbered order or an assignment of responsibilities. CAUTIONS and WARNINGS notations will be included for the applicable safety hazard before the action is described. Steps with potential for criticality specification violation will be identified. Explanatory "Notes" may be included for clarification of process.

Calculations--Calculations required to complete the work will be described in this section. Examples with sample values may be included. All combined factors will be fully described and units noted.

Calibrations--When calibrations are required, a description of how to carry out required calibrations will be given.

Discussion--A discussion of the theoretical aspects of the procedure. Brief identification of unique characteristics and interfaces to aid in troubleshooting may be included.

References--A reference list of published information to provide technical basis for the procedure may be included.

The mandatory topics are addressed in both procedures. However, the laboratories have technical, analytical, and administrative procedures. Nonmandatory topics are included if appropriate to the activity covered by the procedure.

The calibrations of all laboratory instruments are controlled by the Laboratory Instrument Calibration Control System (LICCS) (WHC-CM-5-4, Section 8.2). The LICCS documents the requirements for and the performance of calibration activities for each analytical instrument or measurement device.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

Three vacuum pumps draw air through the sample transport lines. The two pumps associated with the beta and gamma monitor and backup record sampler operate at 2.0 ± 0.2 ft^3/min while the record sampler operations at 3.0 ± 0.2 ft^3/min. A sample transport line extends from the probe mounting assembly to the monitoring instruments located in Building 292-B, approximately 40 feet from the base of the stack. Four tubes are bound together between the probes and the monitoring instrumentation: one each for the record sampler and the beta and gamma monitor and two tubes comprising the pitot tube assembly (which is discussed in the following section). The sample transport lines are heat traced and insulated to inhibit condensation and the resultant sample flow retardation. The sample transport lines are installed with a minimum number of bends, using a minimum bend radius of ten times the tubing inside diameter. The sample air flows into the monitoring instrument assembly (WHC 1991d).

Record Sampler:
The record sampler sample passes through a record sample filter which collects effluent particulates on a 47-mm-diameter filter paper. The filter papers are exchanged weekly and evaluated for gross alpha and gross beta activities by laboratory analysis. The record samplers provide the basis for reporting the amount and concentration of radionuclides released to the environment. These reports are forwarded to all appropriate organizations and agencies. Downstream of the filter, the record sampler passes through a flow meter, a flow totalizer, a flow regulator, and a vacuum pump. In the event of a low flow in the record sampler line, a local alarm and a remote alarm are activated. The local alarm indicates a low record flow (and is connected to the beacon outside Building 292-B) and the remote alarm in the 271-B dispatchers office indicates a monitor failure (WHC 1991d).

Beta-Gamma Sampler:
Within the monitoring instrumentation rack, the beta-gamma sample passes through a flow splitter and is divided into two parts: The first split passes through a beta-gamma continuous monitor equipped with both a local and a remote (271-B dispatcher's office) alarm. The monitor continuously monitors particulate matter buildup on filter paper for the detection and measurement of beta and gamma radiation. The filter paper is collected weekly and analyzed for gross beta and gamma readings. In the event of the radiation buildup exceeding established parameters, a remote stack radiation indicator alarm is activated, as is a local high-beta radiation alarm. The local alarm is connected to both a bell and a beacon outside Building 292-B. After the monitor, the sample passes through a flow regulator and a vacuum pump. In the event of low flow in the beta-gamma sample line, a local alarm and a remote alarm are activated. The local alarm indicates a low beta flow (and is connected to the beacon outside the 292-B building) and the remote alarm in the 271-B dispatcher's office indicates a monitor failure.

The second split passes through a backup record sampler, which consists of a 47-mm-diameter filter that collects the effluent particulates. After the filter, the split passes through a rotameter (flow meter), a flow regulator, and a vacuum pump. In the event of a low flow in the backup sampler line, a local alarm and a remote alarm are activated. The local alarm indicates low back-up record flow (and is connected to the beacon outside Building 292-B) and the remote alarm in the 271-B dispatcher's office indicates a monitor failure (WHC 1991d).

Calibration and inspection of the system are accomplished at the following intervals:

Procedure	Frequency
PROC 5.2.2.6	Weekly
PSCP-3-002	Monthly
PSCP-4-007	6 Months
PSCP-4-091	6 Months
PSCP-6-029	6 Months
PSCP-7-001	6 Months

Titles of these procedures are presented below:

Health Physics Procedure No. 5.2.2.6, Rev 2, Gaseous Effluent Sampling and Monitoring System Operability Inspection

Maintenance Engineering Services Calibration Procedure PSCP-3-002, Eberline Beta Air Monitor, Models AMS-3, AMS-3A, and 700300

Maintenance Engineering Services Calibration Procedure PSCP-4-007, Rockwell Type Gas Meter

Maintenance Engineering Services Calibration Procedure PSCP-4-091, Pressure and Vacuum Gauges

Maintenance Engineering Services Calibration Procedure PSCP-6-029, Chem-Tec Adjustable Flow Switch Model 500

Maintenance Engineering Services Calibration Procedure PSCP-7-001, Air Rotameter

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

The flow rate is measured continuously. The pitot tube assembly is comprised of two tubes that measure the static and total pressure in the stack air space, from which the flow rate can be determined and sent to the Facility Process Monitor Control System (FPMCS) by a flow transmitter. In the 271-B dispatchers office, stack flow rate is displayed and trended by the FPMCS (WHC 1991d).

The calibration and inspection is performed every 6 months using Maintenance Engineering Services Calibration Procedure PSCP-6-032, Bailey Electronic DP Transmitter Type BCX Series.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

The accuracy of all analyses is checked using percent recovery. The evaluation of blind or known check standards provides the percent recovery.

For both blind and known check standards, percent recovery is calculated by the following equation:

$$P = 100 \cdot \frac{R}{S_t}$$

Where:

P = Percent recovery
R = Measured or recovered analyte concentration in the check standard
S_t = Concentration of analyte in the check standard.

The laboratories do not use manual W. A. Shewhart control charts (Shewhart 1931). The Laboratory Measurement Control System (LMCS) is a software package designed for support of management quality control decisions. Each analytical measurement system has different control parameter requirements based on the use of specific standards. The LMCS program provide a performance versus limits control chart for each standard. The average percent recovery (P) or 100 percent, depending on the method, marks the center of the limit. The upper and lower boundaries of the limits are multiples of the standard deviation (s) of the average percent recovery. The laboratory manager approves the LMCS limits, defined as P ± ns, where n is a positive number. The values for P and s are either performance based or set administratively. In general, laboratory management sets the warning limits at 2s and the control limits at 3s or their equivalent.

When the LMCS identifies an out-of-control method, it automatically initiates corrective action. The system issues an Off-Standard Condition Report (OSCR). The scientist in charge of the method must discover and resolve the problem to close out the OSCR. Until the OSCR has been clear, personnel can not perform any analyses by this method. After the scientist has resolved the problem, personnel evaluate all analyses performed since the last in-control point.

The laboratories assess precision by examining the results from split samples or laboratory duplicates. Percent relative difference measures the precision of analyses. Percent relative difference is computed by the following equation:

$$RD = 100 \cdot \frac{S_d}{X}$$

Where:

RD = Percent relative difference
S_d = The standard deviation estimate of the duplicate data set
$\bar{X}$ = The arithmetic mean (average) of the duplicate data set.

The initial QA objective for completeness of analyses in the laboratories is 90 percent. This means that the goal is to produce usable analytical data for a minimum of 90 percent of the analyses requested on all samples submitted to the laboratory. The laboratory evaluates actual performance against the 90-percent objective. If the laboratory performance drops below this limit, laboratory management initiates corrective action. This action shall identify and correct those activities within the laboratory that have caused the drop in performance. The objectives are documented in the Environmental Protection Quality Assurance Project Plan (QAPjP) (WHC 1992d).

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

The samples analyzed under this program consist of mounts made from preparation of stack filters. Each sample collection point produces only one sample which is sent to the laboratory for analysis. No replicate samples are available. Repeat measurement of individual samples are made at the discretion of the scientist in charge.

As a type of process control samples, stack filters are not subject to matrix effects and radionuclide spikes are not used. However, tracer elements ^{243}Am and ^{236}Pu support the analysis of ^{241}Am, ^{238}Pu, and $^{239,240}Pu$ in the quarterly composite of weekly filter samples.

The laboratory does not split samples. There is no guarantee that the distribution of material on the filter will be homogenous. Because of this, no subsampling procedure, such as splitting, can be assured of producing two representative portions. Also, splitting the sample in effect dilutes the sample, which would adversely effect the method detection limits.

Formal blanks are not available for this analysis. However, prior to the analysis of a batch of samples, the background of the counting instrument is checked. This background check is made on each planchet and planchet holder.

Control charts and standards used in support of this analysis are described in Section 4.4 above.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

See Section 6.2.3 of WHC-EP-0536 (WHC 1991c).

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

See Section 7.0 of WHC-EP-0536.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

See Section 8.0 of WHC-EP-0536.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

See Section 9.0 of WHC-EP-0536.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The QA Program addressing Stack 291-B-1 will be documented in a future QAPjP.

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- H-2-91208, *Generic Stack Beta Record Rack Assembly*
- H-2-92488, *Generic Stack Sampler/Monitor modified Monitor Assembly*
- H-2-92489, *Generic Stack Sampler/Monitor Record Sample Loop Assembly*
- H-2-92490, *Generic Stack Sampler/Monitor Sample Extraction Assembly*
- H-2-92514, *Differential Pressure Transmitter and Manifold Assembly*
- H-2-94158, *Elect/Instm/Dwg List Site Plan and Details, 291-B-1 Sampler/Monitor*
- H-2-94159, *Probe Assembly 291-B-1 Stack Sampler/Monitor*
- H-2-96550, *IEFD B Plant Area Stack Monitors 291-B-1*
- W-69512, *291-B-T-U Concrete Stack Foundation Details*
- W-73544, *221 T-U-B Concrete Ducts and Pits, Plans and Details*
- HW-72051, *Building No. 291 T, U, B Ventilation Exhaust Units Arrangement*
- W-72438, *Building No. 291 T-U-B Ventilation Exhaust Stack Breeching Arrangement*

- ES-BPF-70174, *Reinforced Concrete Chimney Lined Process Stack Eq Pc 291-B-C-T-U-901* (Note: This drawing represents a condensed recreation of the original Rust Engineering blue print file 70174 of July 10, 1943. The original contract called for four tapered reinforced concrete stacks, circular in section, with acid proof brick lining. Stacks to be 200'0" above foundations - inside diameter at top 5'0". Hole drilled in concrete column adjacent to ladder at a point 50'0" above top of foundation.)

WHC, 1992a, *Building Emergency Plan for B Plant Complex*, WHC-IP-0263-BCP, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992b, *Laboratory Procedures*, Westinghouse Hanford Company, Richland, Washington.

- LA-150-115, *Instrument Standards Counting Frequency--222-S Counting Room*
- LA-218-112, *Instrument Standards Counting Frequency--222-S Counting Room*
- LA-220-103, *Strontium-89, 90 and/or Strontium-89 and 90 from Leachates of Soil, Vegetation, Air Filters, and Other Solid Samples*
- LA-288-101, *Gamma Analysis of Silver Zeolite Cartridges in the 222-S Counting Room*
- LA-348-101, *Carbon-14 by Distilling and Liquid Scintillation Counting*
- LA-508-051, *Alpha Energy Analysis using the Canberra Jupiter Systems*
- LA-508-052, *Gamma Energy Analysis on the Canberra Jupiter System*
- LA-508-110, *Operation of the Tennelec LB-5500 Alpha/Beta Counting System*
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- LA-508-121, *Operation of the Beckman Liquid Scintillation Counters*
- LA-542-101, *Electrodeposition of Actinides*
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- LA-925-107, *Uranium by Laser Induced Kinetic Phosphorescence Analyzer*
- LA-943-123, *Separation of Pu and Am by Ion Exchange,*
- LO-150-133, *Processing Record Stack and Red Bordered Emergency Air Samples*
- LQ-508-002, *Calibration Guidelines for Window Type Gas Flow Alpha/Beta Proportional Counters*
- LQ-508-003, *Calibration of the Jupiter Gamma Energy Analysis Systems*
- LQ-508-005, *Calibration of Beta Detector for Sr-90 and Y-90*
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- WHC-CM-1-3, *Management Requirements and Procedures*
- WHC-CM-4-1, *Emergency Plan*
- WHC-CM-4-2, *Quality Assurance Manual*
- WHC-CM-4-3, *Industrial Safety*
- WHC-CM-4-10, *Radiation Protection*
- WHC-CM-4-12, *Health Physics Practices Manual*
- WHC-CM-4-15, *Radiation Work Requirements and Work Permits Manual*
- WHC-CM-4-29, *Nuclear Criticality Safety*
- WHC-CM-4-43, *Emergency Management Procedures*
- WHC-CM-4-44, *Emergency Preparedness Administrative Manual*
- WHC-CM-5-4, *Analytical Chemistry Services Laboratories - Operating Instructions*
- WHC-CM-7-5, *Environmental Compliance Manual*

WHC, 1992d, *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, WHC-EP-0528, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

METHOD 114 COMPARISON FOR STACK 291-Z-1

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APPENDIX C

METHOD 114 COMPARISON FOR STACK 291-Z-1

This section provides a line-by-line evaluation of quality assurance method requirements outlined in 40 CFR 61, Appendix B, Method 114, as they apply to the 291-Z-1 stack at the Plutonium Finishing Plant (PFP), Hanford Site.

METHOD 114-TEST METHODS FOR MEASURING RADIONUCLIDE EMISSIONS FROM STATIONARY SOURCES

1.0 Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2.0 Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

The filter media used to remove the particulates is a 47-mm Versapor* 3000 or equivalent air sample filter as described by WHC-CM-4-13, Section 5.5.5.7, REV 2.

2.2 Radionuclides as Gases.

The 291-Z-1 stack does not exhaust radionuclide gases; therefore, this section is not applicable to this stack.

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*Trademark of Gelman Sciences, Inc.

2.3 Definition of Terms

No response required.

3.0 Radionuclide Analysis Methods

The analysis methods have been evaluated by the 222-S Laboratory cognizant personnel and are included as Appendix G.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-1, REV 1, *Emergency Plan*. This manual contains an emergency preparedness plan to protect onsite personnel, public health and safety, and the environment in the event of operation, natural phenomena, and/or safeguards and security events at Westinghouse Hanford Company (Westinghouse Hanford) facilities. The requirements stated in the emergency preparedness plan are implemented through subtier plans and implementing procedures. These implementing plans and procedures established for response to emergencies by Westinghouse Hanford personnel and emergency management organizations are contained in WHC-CM-4-43, *Emergency Management Procedures*; WHC-CM-4-44, *Emergency Preparedness Administrative Manual*; various building emergency plans; and Westinghouse Hanford facility operating procedures (WHC-IP-0263-PFP).

WHC-CM-4-12, Section 1.14, REV 0, "Alarm Response and Management." This section provides guidance and sets requirements for managing the responses to alarms that are the responsibility of Occupational Health and Safety (OHS). This practice is applicable to all members of the OHS. Area OHS managers shall ensure that all members of their organizations are aware of and adhere to this practice.

WHC-CM-4-12, Section 2.1, REV 0, "Radiological Problem Reporting Program." The purpose of this section is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Section 12.1, REV 1, "Emergency Response." An emergency is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To be able to perform this function, HP personnel receive training to respond to a variety of emergency situations. The HP procedures (WHC-IP-0692 and WHC-CM-4-12) are written to provide guidelines to respond to emergencies. Together, the training and the written procedure detail the HP emergency response program.

Emergency Response. The HP personnel, in many situations, are the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel use their training and experience to make decisions during the initial response to an emergency.

An emergency response may be initiated by (1) personnel observing the event, (2) alarms, (3) the Patrol Operation Center, or (4) the Emergency Control Center(s) once they are manned. The type of emergency determines the level of planning for HP response. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person such as a firefighter or patrol. If a rapid response is required, no undue risks should be taken nor should personnel safety be compromised. When an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route, etc.) and approval of the Building or Facility Emergency Director is necessary to re-enter.

Although HP personnel respond to an emergency using basic guidelines, an area or facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 12.1.2.6, REV 0, "HP Response to Room 221A & Room 631 Annunciator Panel Alarms." This procedure provides the HP staff at PFP the information and required actions needed to respond to a radiation or contamination-related alarm.

WHC-IP-0692, Section 5.2.2.6, REV 2, "Gaseous Effluent Sampling and Monitoring System Operability Inspection." This procedure establishes the method of inspection, evaluation, and discrepancy reporting of the operational status of Gaseous Effluent Monitoring Systems (Stack Packs), in use in the 200 East and West Areas.

WHC-CM-4-13, Section 5.2.2.7, REV 2, "Operation of Gaseous Effluent Sampling and Monitoring Systems." This procedure establishes the standard method of operation of Gaseous Effluent Sampling and Monitoring Systems (Generic Stack Packs) in use in the 200 East and West Areas.

WHC-DI-33920-010, REV 0, *Operation and Inspection of PFP Stack Sampling and Monitoring Systems*. This desk instruction provides PFP and stack-specific implementing procedures and references for the effluent sampling and monitoring systems including response to alarms.

WHC-CM-4-13, Procedure No. 12.1.2.3, REV 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, effluent exhaust continuous air monitor (CAM) systems in an expedited fashion.

WHC-IP-0263-PFP, Section 6.0, REV 2, "Emergency Response Plans." This procedure establishes guidelines for actions to be taken if the PFP discharges highly radioactive gaseous material.

WHC-CM-5-8, Procedure 1.5, REV 2, "Non-Routine Release Response." This procedure details the response actions to non-routine releases as evidenced by high sample results from gaseous effluent samples at the PFP.

WHC-IP-0692, Procedure No. 12.2.1, REV 2, "Emergency Response Air Sampling." This procedure describes the guidelines and steps for emergency air sampling inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team and the HP Technicians Field Survey Teams. This procedure describes the steps for an initial emergency response by the HP Emergency Response Team and HP Technicians Field Survey Teams. The HP Emergency Response Team and the HP Technicians Field Survey Teams may be requested to respond to an emergency when an environmental release of radioactive material may extend beyond the control of a facility or outside the Hanford Site boundaries. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, REV 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a beta-gamma plume created from a radioactive material release to the environment and determine if it is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instruction given in WHC-CM-7-5, *Environmental Compliance Manual*, and WHC-IP-0263-PFP, *Building Emergency Plan for Plutonium Finishing Plant Complex Emergency Response Plans*, Section 6.6, "Radioactive Materials Response Plan." The purpose of these manuals and sections is to establish and implement specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences at the

PFP, as required by WHC-CM-1-3, MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

A continuous effluent sample is extracted from the 291-Z-1 stack by a single probe located at the 15 m (50 ft) level of the stack. The stack diameter at this location is 15.75 ft. The nearest flow disturbances are at the inlet and outlet of the stack, approximately three stack diameters downstream and nine stack diameters upstream from the sampling location. The 15 m (50 ft) sampling location was selected after extensive studies were performed. The presence of an existing penetration in the stack at this level was an important factor in sample site location as this supplied Pacific Northwest Laboratory (PNL) an access point through which instrumentation could be inserted to study the effluent characteristics. The site was proven to be acceptable for sampling.

This sampling location meets the stack diameter requirements of 40 CFR 60, Method 1.

4.3.2 A description of sampling probes and representativeness of the samples.

The sampling probe consists of six nozzles branching from a single sample delivery line and is entirely of 300-series stainless steel (drawings H-2-28543 and H-2-28545). The collection probe spans the diameter of the stack with the nozzles centered in six equal annular areas. The bend radii of the collection tubes are 2.5 times the tube radius or 1.25 times the tube diameter. The sample delivery line increases in diameter as each branch line joins to keep the mass flow rate consistent with sample velocity. The probe delivers the sample to a 300-series stainless steel flow splitter for record and CAM samples.

The velocity distribution at the sampling site was measured before sampler construction. But as stated in ANSI N13.1-1969, "as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." Therefore, velocity distribution is of lesser importance for the 291-Z-1 stack as the flow is highly turbulent (Reynolds Number = 2,000,000). The flow rate for the 291-Z-1 stack varies only a few percent. The variation in 1988 was determined to be only 3% and for 1991 a variation of 4.5% was observed. Given these facts, the sample probe provides the sample collection system with a representative, isokinetic sample.

4.3.3 A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable--emissions are not monitored continuously.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The sample collection probe extracts effluent from the stack at a flow rate of 4 std. ft^3/min. The sampler probe uses six nozzles for sampling the stack flow (drawing H-2-28545). A sample transport line extends approximately 1 m, horizontally, from the stack surface connection flange to the monitoring instruments located within an adjacent, elevated sample shack. The sample transport line is heated by a baseboard heater immediately below the line within the building to inhibit condensation of moisture and resultant sample flow retardation by maintaining the temperature above the dewpoint. The sample transport line was selected and installed to minimize particle loss attributed to gravity settling and turbulent impaction. The transport line length and tube transition severity of the sample transport line were minimized. The bend radii are 1.25 times the inside diameter of the collection tube. Once the extracted sample is delivered to radiation monitoring system instrumentation, the sample stream passes through a flow splitter and is divided into two equal parts: the record sample loop and the CAM loop.

Particulate radionuclides are collected with a record sampler. The record sampler collects the particulates on a 47-mm-diameter filter (Gelman Sciences, Versapor 3000, 3 μm or equivalent). This filter is a membrane filter composed of acrylic copolymer cast on a non-woven nylon substrate good for collecting 0.3-μm size particles with a 91% collection efficiency in air applications. The record sampler provides a representation of the amount and concentrations of radioactive particulates being discharged. The record samples provide the basis for reporting the amount and concentration of radionuclides released to the environment. The filter media is exchanged weekly and evaluated for gross alpha and gross beta activities by laboratory analysis. The filter media is then composited for quarterly analysis of specific radionuclide concentrations.

The CAM loop collects particulate matter in a similar fashion to that of the record sampler, but the CAM monitors for elevated radioactivity on the filter. This instrument provides process control and backup capability for the record sampler. The CAM is calibrated annually.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured. including frequency of analysis calibration procedures and frequency of calibration.

Refer to Appendix G.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

The sample flow rate is measured and regulated by instruments located downstream of the sample collection filter and CAM. The record sample loop passes in turn through an integrating flow meter (totalizer), a sight flow indicator (rotameter), a vacuum pressure indicator, a vacuum switch, a flow regulator, and a vacuum pump. The flow rate regulator is provided to maintain a constant flow rate through the collection filter assembly to compensate for filter-loading effects. Audible and visible alarms signals indicating low vacuum pressure are provided remotely in the HP office and the power control room (both constantly manned locations). The calibration procedures and frequencies are summarized in Table C-1.

Table C-1. Calibration Procedures and Frequencies for Record Sampler (Sample Flow Measurement Devices).

Component	Procedures	PISCES*	Frequency
Vacuum gauge	PSCP-4-091 7-GN-038	E0004-2	6 month
Flow totalizer	PSCP-4-007 7-GN-038	E0005-1	3 month Install/annual
Rotameter	PSCP-7-001 7-GN-038	Y0016-C	6 month
Vacuum switch	PSCP-6-011 7-GN-038	E0005-2	6 month

*WHC-CM-8-2

The CAM loop differs only in that the sight flow indicator is an integral part of the CAM itself and that there is no flow totalizer. All other flow measurements, regulations, and monitoring is identical to that of the record sampler loop. The calibration procedures and frequencies are summarized in Table C-2.

Table C-2. Calibration Procedures and Frequencies for Continuous Air Monitor Sampler (Sample Flow Measurement Devices).

Component	Procedures	PISCES	Frequency
Vacuum gauge	PSCP-4-091 7-GN-038	E0004-1	6 month
Continuous air monitor/rotameter	PNL-MA-563		6 month
Vacuum switch	PSCP-6-011 7-GN-038	E0005-3	6 month

Independent vacuum pumps are provided for each loop of the system. Redundant vacuum systems are not furnished, but failure annunciation (low flow rates) is provided and checked periodically to demonstrate operability.

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

The volumetric flow rate for the 291-Z-1 stack is determined by the summation of independent flow rates of five tributary effluent streams. The streams are independently measured in accordance with pre-approved procedure PFP-PAP-076, "Stack Flow Measurements," which references the vent and balance procedure 7-GN-56. The measurement locations and methods do not strictly conform to the criteria of 40 CFR 60, "Methods." The flow rate is directly measured with a standard pitot tube. The measurement locations are very close to flow disturbances both upstream and downstream. The building ductwork design does not allow for alternatives. The flow rates are determined quarterly as the flow rate does not widely vary.

Plans to fully comply with measurement requirements are underway at this time. Site selection is to be based on the criteria of 40 CFR, Part 60, Appendix A, Method 1. If a continuous measurement system is install, it will be certified in accordance with 40 CFR, Part 60, Appendix E.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

See Appendix G.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

See Appendix G.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

See Section 6.2.3 of the main body of this document.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

See Section 7.0 of the main body of this document.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

See Section 8.0 of the main body of this document.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

See Section 9.0 of the main body of this document.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The quality assurance program addressing stack 291-Z-1 is documented in WHC-EP-0561, Quality Assurance Project Plan for the Radionuclide Airborne Emissions for the Plutonium Finishing Plant. This is supplemented by WHC-EP-0528, Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting.

REFERENCES

40 CFR 60, "Standards of Performance of New Stationary Sources," Title 40, *Code for Federal Regulations*, Part 60, as amended, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code for Federal Regulations*, Part 61, as amended, U.S. Environmental Protection Agency, Washington, D.C.

ANSI, 1969, *Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility*, ANSI N13.1-1969, American National Standards Institute, New York, New York.

Drawing H-2-28543, Sample Probe Installation Arrangement, Westinghouse Hanford Company, Richland, Washington.

Drawing H-2-28545, Sample Probe Assembly, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services, Rockwell Type Gas Meter, PSCP-4-007, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services, Pressure and Vacuum Gauges, PSCP-4-091, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services, Diaphragm-Operated Pressure Switches, PSCP-6-011, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services, 1989, *Calibration Procedure, Air Rotometer*, PSCP-7-001, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

PFP-PAP-076, Pre-approved Procedure, Vent & Balance Quarterly Stack Flow Measurements, Rev. 0, 1991, Westinghouse Hanford Company, Richland, Washington.

Procedure 7-GN-038, Pisces Recalled Instrumentation Maintenance Activities, Westinghouse Company, Richland, Washington.

Procedure 7-GN-56, Airflow Capacity and Distribution Tests, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-3, *Management Requirements and Procedures*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-1, REV 1, *Emergency Plan*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-12, *Health Physics Practices Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-13, *Health Physics Procedures Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-8, *Plutonium Finishing Plant Administration*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-5, *Environmental Compliance Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-43, *Emergency Management Procedures*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-44, *Emergency Preparedness Administrative Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-8-2, *200 Area Support Service*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-DI-33920-010, REV 0, *Operation and Inspection of PFP Stack Sampling and Monitoring Systems*, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0528, *Quality Assurance Project Plan for Radioactive Airborne Emissions Data Compilation and Reporting*, J. M. Nickels, 1992.

WHC-EP-0561, *Quality Assurance Project Plan for the Radionuclide Airborne Emissions for the Plutonium Finishing Plant*, J. G. Kristofzski and D. Alison, 1992.

WHC-IP-0263-PFP, *Building Emergency Plan for Plutonium Finishing Plant Complex Emergency Response Plan*, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0692, *Westinghouse Hanford Health Physics Procedures Manual-All Areas*, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX D

METHOD 114 COMPARISON FOR STACK 296-A-22

G. M. Crummel

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APPENDIX D

METHOD 114 COMPARISON FOR STACK 296-A-22

1.0 Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2.0 Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

Plant Documentation

Gelman Sciences, Inter-Office Memorandum to Karol Butcher, October 30, 1991, RE: Versapor 3000, DOP efficiency.

WHC, 1992, *Health Physics Procedure Manual*, WHC-IP-0692

"Operation of Gaseous Effluent Sampling and Monitoring Systems," Health Physics Procedure No. 5.2.2.7, Rev 3

Drawing H-2-92505, Sheet 1 of 4 - Vessel Vent Stack Monitor System Installation

Drawing H-2-92505, Sheet 2 of 4 - Vessel Vent Stack Monitor Details

Drawing H-2-92505, Sheet 4 of 4 - Vessel Vent Stack Monitor Flow Diagram

Response. A 47-mm Versapor* 3000 or equivalent air sample filter is used for the record sampler. This filter is a membrane filter good for collecting 0.3-μm size particles with a collection efficiency of 91%.

2.2 Radionuclides as Gases.

Plant Documentation

WHC, 1992, *Health Physics Procedure Manual*, WHC-IP-0692

- "Silver Zeolite Monitor/Change-Out Program At 241-AW Tank Farm And The 242-A Evaporator," 200 Area Health Physics Procedure No. 5.2.2.5, Rev 1

Drawing H-2-92505, Sheet 1 of 4 - Vessel Vent Stack Monitor System Installation

Drawing H-2-92505, Sheet 2 of 4 - Vessel Vent Stack Monitor Details

Drawing H-2-92505, Sheet 4 of 4 - Vessel Vent Stack Monitor Flow Diagram

Response -- Silver zeolite cartridges are used and are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru.

2.3 Definition of Terms

No response required.

3.0 Radionuclide Analysis Methods

The analysis methods have been evaluated by 222-S Laboratory cognizant personnel and are included as Appendix G.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

*Trademark of Gelman Sciences, Inc.

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

The Organizational Structure

See Section 6.2 of the main part of this document for the organizational structure.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

"WHC-CM-4-12, Part B, Section 1.14, REV 1, "Alarm Response and Management." Establishes requirements and provides guidance for responding to alarms that are the responsibility of Health Physics (HP)."

WHC-CM-4-12, Part A, Section 2.1, REV 0, "Radiological Problem Reporting Program." The radiological problem reporting program provides a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Part B, Section 12.1, REV 1, "Emergency Response." An emergency is a sudden, unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To perform this function, HP personnel receive training to respond to a variety of emergency situations. The HP procedures are written to provide guidelines to respond to emergencies. Together, the training and the written procedure detail the HP Emergency Response Program.

Emergency Response. The HP personnel are, in many situations, the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by personnel observing the event, alarms, the Patrol Operation Center or the Emergency Control Center(s) once they are manned. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person, or other emergency service person such as fire or patrol. A rapid response is required; however, no undue risks should be taken nor should employee personnel safety be compromised. The type of emergency determines the level of planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive

spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route, etc.) and approval of the Building/Facility Emergency Director is necessary for a re-entry.

Although HP personnel respond to an emergency using basic guidelines, an area/facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 12.1.2.3, REV 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, effluent exhaust CAM* systems. This procedure describes the steps and material necessary to exchange, perform field concentration calculations, and submit suspect samples for "rush" or "red envelope" analysis when responding to alarms on effluent exhaust CAM systems.

WHC-IP-0692, Section 12.1.6, REV 2, "Stack Effluent Release Response." This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks. The procedure describes the immediate actions to respond to an exhaust CAM stack alarm (i.e., CAM monitoring downstream or upstream of the final filtration).

WHC-IP-0692, Procedure No. 12.2.1, REV 2, "Emergency Response Air Sampling." This procedure establishes the instruction and guidelines for air sampling in an emergency situation. The procedure describes the steps for sampling air both inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure, responsibilities, and steps for an initial emergency response for the HP Emergency Response Team (ERT) and the HP Technician (HPT) Field Survey Teams. The HP ERT and the HPT Field Survey Teams may be requested to respond to an emergency when it is deemed that an environmental release of radioactive material may extend beyond the control of a facility or outside the boundaries of the Hanford Site. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, REV 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a plume created from a radioactive material release to the environment. This procedure describes the steps to track and determine if a radioactive beta-gamma plume is at ground level or at an elevated level.

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*The CAM serves as a warning device to alert personnel to releases that exceed normal operating parameters. A CAM collects particulates on a filter monitored continuously by a radiation detector. The CAM filter may be used as a backup for the record sample.

Notifications and reporting of specific events related to environmental releases and events involving effluents or hazardous materials are reported via instruction given in WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, Section 1.22, "Tank Farms Occurrence Reporting and Processing of Operations Information." This procedure establishes and implements specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences at the tank farms, as required by WHC-CM-1-3, MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

The vessel vent stack is 20.3 cm (8 in.) in diameter. The sample probe location within the vessel vent stack is located on the fourth floor of the condenser room. The closest flow disturbances are described below.

- Downstream--the sample return line enters the stack approximately 61 cm (2 ft) below the probe location. This equates to three stack diameters.

- Upstream--the elbow in the vessel vent which takes the stack outside the building is approximately 1.4 m (56 in.) above the probe. This equates to seven stack diameters.

This meets the criteria established in 40 CFR 60, Appendix A, Method 1A.

There are two nozzles on this probe. This is as recommended in American National Standards Institute (ANSI) N13.1-1969, Appendix A, Section A3.2 (ANSI 1969), for this size stack (8 in.).

4.3.2 A description of sampling probes and representativeness of the samples.

The sample probe consists of two inlets that point down into the upflowing gas. Each inlet is approximately centered in each of the two equal annual areas. This is shown on drawing H-2-69316. It is easily shown (from Table A1, ANSI N13.1-1969, and from information on the stack flow rate) that the flow within the stack is highly turbulent resulting in a uniform velocity distribution across the cross-sectional area of the stack. As stated in ANSI N13.1-1969, Appendix A, Section A3.3.2, "as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." Based on this it can be shown that the sampling probe is isokinetic. See discussion in Section 4.3.6."

4.3.3 A description of any continuous monitoring systems used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable; emissions are not monitored continuously for compliance demonstration. See discussion in Section 4.3.6.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The radionuclides are collected through the probe discussed in Section 4.3.1 above. Gaseous radionuclides are collected with silver zeolite cartridges that are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. The gross filter efficiency of a silver zeolite is based on the particular absorbed/adsorbed radionuclide being evaluated and the porosity of the filter. For uses at the Hanford Site (i.e., ruthenium, iodine), the efficiency is 99.2 to 99.98 (taken from Table 0-2 of *Air Sampling Instruments*, American Conference of Governmental Industrial Hygienists, seventh edition [ACGIH 1989]).

The silver zeolite cartridges are exchanged as follows:

- **When the cartridges have been in the sample for 1 week**
- **When radiation readings indicate a buildup of greater than 16 mrem/hour within the last 8 hours**
- **When requested by operations management.**

Particulate radionuclides are collected with a record sampler. The record sampler uses a 47-mm Versapor* 3000 or equivalent air sample filter for the record sampler. This membrane filter collects 0.3 μm size particles with a collection efficiency of 91%.

If at all possible, record air samples are left running for a full 168-hour (7-day) week to ensure a representative sample.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis calibration procedures and frequency of calibration.

See Appendix G.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

The sample collection and monitoring system consist of a record sampler, two silver zeolite cartridges, and two Continuous Air Monitors (CAMs). The record sample and silver zeolite portion of the sampling system is considered the regulatory portion of the system. The record sampler and silver zeolite cartridges provide the basis for reporting the amount and concentration of

radionuclides released to the environment. The generated reports are forwarded to all appropriate organizations and agencies. The CAMs are considered operational safety devices and are set to alarm if emissions are detected above preset levels. The difference between the CAMs and the record sampler is the fact that there is a radiation detector above or near the collection filter within the CAM. The record sampler contains only a collection filter. If the filter paper of the record sampler is not useable for some reason when it is exchanged for analysis, the filter paper from one of the CAMs could be used instead. For this reason the CAMs may be considered as regulatory backup devices. The detector portion (and the associated electronics) of the CAMs are not considered regulatory.

The sampling system is designed with a single sampling probe. The sample from the probe is split once and routed to the record sampler (the silver zeolite cartridges are installed just after the record sampler) and to another splitter. This second splitter splits the flow again to an alpha CAM and to a beta/gamma CAM.

This sampling system is designed to be isokinetic by sizing the stack's sampling probe to both, a specified sample flow rate and on measured average stack flow rates. For most of Tank Farms the record sampling portion of the sampling system is designed to a 2.2 CFM flow rate. Historically, the 2.2 CFM rate was selected to represent the respiration rate of the "average" worker. A lower flow rate of 2.0 CFM is allowed for the CAMs. However, the design was still for 2.2 CFM. The lower flow rate (2 CFM) theoretically results in the CAMs oversampling the stream. Since CAMs are monitoring devices which provide for notification of increasing particulate radionuclide emissions, this oversampling concept provides for a sort of early warning signal. Somehow, though, over the years the 2 CFM setting for the CAMs has been interpreted to apply to the record samplers as well. Now 2 CFM is the nominally expected setting. Since all three portions (the record sampler and the two CAMs) share the same sampling probe, the sample flow rate is readily calculated to be 2.8 L/sec (6 ft^3/min [cfm]).

The entire sampling collection and monitoring system is considered to consists of the following elements:

- The sampling probe which withdraws the sample from the stack.
- The sample transport line which transports the sample to a sample collection and/or other detection devices.
- The collection and/or detection devices.
- The rotameter which measures the flow through the system.
- The gasmeter or totalizer which totals the sample flow.
- The pressure or vacuum gauge which measures the vacuum in the system.

- The flow switch (also called the pressure switch) indicates when the sample flow falls below established limits.
- The flow regulator which adjusts to maintain an established flow rate within the system.
- The vacuum pump which supplies the flow through the system.
- The timer which indicates the length of time the collection devices have been collecting a sample.

Each of these elements are discussed in further detail below.

THE STACK'S SAMPLING PROBE AND SAMPLE TRANSPORT LINE: The sampling probe withdraws a sample from the stack section located on the fourth floor of the condenser room. The sampler probe incorporates the use of two nozzles for sampling the stack flow (reference drawing H-2-69316 [AEC 1974]). At an actual sample flow rate of 2.0 CFM (the record sampler and the two CAMs total 6.0 CFM) the nozzles are sized to be isokinetic at an actual stack flow rate of 750 CFM. A further analysis is given under the rotameter discussion below.

The sample transport line was selected and installed in a manner designed to minimize particle loss attributed to gravity settling, turbulent impaction, and electrostatic effects. The run lengths, bend radii, and tube transition severity of the sample transport line are minimized to the extent practical. This line extends from the sample probe down to the top of the instrument rack located on the third floor of the condenser room. The line is approximately 10.5 feet long and contains two 45° bends designed with bend radii of not less than 10 inches. The line is sized to 1" OD by 0.065" WALL. The sample transport line is heat traced (operating at 43 °C [110 °F]) to inhibit condensation of moisture and resultant sample flow retardation by maintaining the temperature above the dew point.

THE RECORD SAMPLE COLLECTION FILTER PAPER AND HOLDER: The record sample collection filter paper collects particulate radionuclides from the stack or stream. The filter used is a Gelman Sciences Versapor 3000 - Supported Membrane type. The manufacturer specifies that this filter has a 91% collection efficiency for 0.3 micron particles (reference Gelman Sciences, Inter-Office Memorandum to Karol Butcher, October 30, 1991, RE: Versapor 3000, DOP efficiency).

The make/model of the filter holder is BGI INC FI (reference drawing H-2-92489). The record sample holder is described as follows:

- Large outside diameter with knurled outer ring for ease of opening.
- Rubber "O" ring gaskets used to seal the sample holder.

- Fine mesh screen behind the sample filter to keep the sample a constant distance from the inlet.

The holder is inspected for wear and leaks on a daily, weekly, and monthly basis per Health Physics Procedure 5.2.2.6, Rev 3, "Gaseous Effluent Sampling and Monitoring System Operability Inspection." The filter paper is exchanged on a weekly basis per Health Physic Procedure 5.2.2.7, Rev 3 "Operation of Gaseous Effluent Sampling and Monitoring Systems," Health Physics Procedure No. 5.2.2.7, Rev 3. The Health Physic Procedure are contained in WHC, 1992, *Health Physics Procedure Manual*, WHC-IP-0692.

THE SILVER ZEOLITE CARTRIDGE: Directly after the record sampler, the flow passes through two silver zeolite cartridge filters. These filters collect volatile radionuclides. Silver zeolite filters are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. The cartridge filters are exchanged weekly and sent to the laboratory for analysis per Health Physics procedure No. 5.2.2.5, Rev 1, "Silver Zeolite Monitor/Change-Out Program At 241-AW Tank Farm And The 242-A Evaporator."

THE ROTAMETER measures the flow rate through the sampling system. The rotameter consists of a ball floating in a column of fluid (air) in a tube. There is no calibration. This model has neither flow adjustment nor calibration scale adjustment. The manufacturer states: "...If used in the proper application, with an acceptable media, the flowmeter will give a lifetime of service without the need for calibration" (reference DWYER INSTRUMENTS, INC letter to WHC, addressed to Jeff Summerhays, dated September 28, 1992). The manufacturer mentions checking calibration only in the shop with a certified air flow device. The operating instructions state "DO NOT attempt to check the Dwyer Rate-Master Flowmeters with a similar flowmeter as seemingly unimportant variations in piping and back pressure may cause noticeable differences in the indicated reading..." (CVI file 20553, dated August 14, 1980).

The applicable drawing for this rotameter is H-2-92489 and it specifies the following:

Make/Model:	DWYER/RMC-103PF
Scale:	10" SCALE, 20 - 200 SCFH
Accuracy:	±10% AT 2.2 SCFM

The facility instrument number is FI-VV-1. This instrument is scaled in units of 5 SCFH (0.08 SCFM) and is readable to ±2.5 SCFH (0.04 SCFM).

This instrument is designed to operate in pressures up to 35 psi and in temperatures up to 130 °F. However, the readout is designed to be accurate only at standard condition of pressure and temperature. Under any other conditions the rotameters give false readings unless compensated for using appropriate equations. The sampling systems are not at standard pressure, and because of this these instruments

do not read true. A special square root function (equation) must be used if the true flow rate is desired. The literature (United States Nuclear Regulatory Commission Office of Inspection and Enforcement, Washington D.C. 20555, dated December 16, 1982, IE Information Notice No. 82-49: CORRECTION FOR SAMPLE CONDITIONS FOR AIR AND GAS MONITORING) gives this equation as:

$$Qs/Qo = Ks/Ko*[(Po*Ts)/(Ps*To)]^{½}$$

where

Qs = Actual compensated sample flow rate.
Qo = Operating condition sample flow reading of the rotameter.
Po = Operating condition sample system vacuum value in inches Hg.
Ps = Standard atmospheric pressure (29.92 inches Hg).
To = Operating condition temperature (°K).
Ts = Standard temperature (294 °K).
Ks = The width of the rotameter chamber in which the ball floats divided by the width of the ball floating in the chamber.
Ko = A function of the operating conditions which may be determined experimentally.

The manufacturer states that the Ks/Ko value is one (per telecon). Apparently this instrument is designed so that these two variables cancel each other out.

A similar equation to that given above is used in emission calculations. However, temperature values are not used. The literature claims that only a ±5% error results if temperature compensations are ignored between 24 and 116 °F. This is the case at Hanford since the emission calculations only compensate for the pressure readings. Typically the operating temperature of the sampling systems can be assumed to be at 110 °F. This is the temperature that the sample transfer line heat tracing is designed to operate at. Accordingly a more exact error* on the rotameter reading due to temperature can be computed to be approximately +4%.

The literature claims that flow rate readings from a rotameter are accurate to ±5% if temperature and pressure are taken into account. The rotameter readings are not compensated in the field. This means that the sample which is collected may not be as representative as it could be. The following example is given to evaluate this:

The equation above is used to calculate what the actual flow rate in the sampling system would be under a typically worse case scenario. In this scenario the system has been adjusted to give a rotameter indication of 2.0 CFM. The following assumptions are used:

- Typically worse vacuum in the system is not greater than 10 inches Hg.

* Error is defined as positive if Qo is greater that Qs.

- It was also mentioned that the heat trace is designed to operate at 110 °F = 316 °K.

Qs = $2.0\{[(29.92 - 10)294]/[(29.92)(316)]\}^{½}$ = 1.57 CFM with an uncertainty of ± 0.14 CFM or the actual flow rate is from 1.71 to 1.44 CFM.

The uncertainty is due to the ±5% error of the rotameter and the ±5% error of the vacuum gauge (see discussion on vacuum gauge below).

The latest stack flow measurement was accomplished on 6/3/93 per Work Package # 2E-93-00672. The flow was measured to be 661 CFM. At that time the vacuum in the sampling system was reading about 6" Hg. Also at that time the rotameter was reading 130 SCFH (2.17 CFM). Using the equation above gives an actual sample flow rate of 1.87 CFM. This 1.87 CFM sample flow rate computes to an isokinetic stack flow rate at 665 CFM (assuming that the CAMs rotameters were indicating the nominal 2 CFM and pressure gauges were indicating approximately the same as the record sample loop's pressure gauge). The actual sample flow rate result can be shown to result in undersampling by less than 1% for 12 micron sized particles (reference Table C1 in ANSI N13.1-1969).

Calibration and inspection of the rotameter has been accomplished, in the past, on a 6 month basis via Maintenance Engineering Services Calibration Procedure, "Air Rotameter," Calibration Procedure #PSCP-7-001. Since the manufacturer, as well as the CVI file (discussed above), indicates that calibration of this instrument is not necessary, a new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077.

THE GASMETER OR TOTALIZER totals the flow through the sampling system. This Gasmeter use to be made by Rockwell but they sold this product line to Equimeter. This totalizer complies with ANSI-ASC B109.1 specifications which states that a meter must remain within ±2.0% accuracy at 1,000,000 cubic feet. This is basically the same system used on homes across the country. The manufacturer supplied data shows that this meter is well within the required accuracy (the regulations specify the accuracy to be within 2%). In fact the data supplied showed this meter to be as accurate to -0.4% at the maximum designed full rate and to +0.2% accurate at 20% of the maximum designed full flow rate for an average volume of 100,000 cubic feet (letter from Equimeter to WHC, addressed to Jeff Summerhays).

The manufacturer is confident that the totalizer can operate for 20 years or more if a clean gas is passed, and the unit is not over pressurized (exceed the maximum flow rate). Over-pressurization would hasten the aging process. The years of residential service referred to here assume approximately 100,000 cubic feet of flow per year (2 million cubic feet in 20 years). Assuming the Vessel Vent

systems operates 24 hours a day at approximately 120 cubic feet per hour, it will pass 2,000,000 cubic feet of air in 694 days (approximately 1.9 years).

This gasmeter was also evaluated in WHC-SD-GN-ES-001, "200 Area - Stack Gas Record Sample Flowmeter." This document states that the useful life of this unit appears to be from one to two years when it is not used in a wet and corrosive environment. When used in a wet and corrosive environment, the failure rate is reported to be from 3 to 6 months.

If this meter goes out of tolerance, the main problem, according to the manufacturer, is wear on the moving parts. When this happens the meters should be replaced. A replacement kit is available for this purpose and can be installed if the meter is found out of calibration.

The applicable drawing for this instrument is H-2-92489 and it specifies the following:

Make/Model:	ROCKWELL MR-9, temperature corrected
Accuracy:	±10% AT 2.2 SCFM

The facility instrument number is FQI-VV-1.

The MR-9 model number relates to the maximum flow for which this gas meter is designed. The 9 can be interpreted as 9 cubic meters per hour. This converts to approximately 5.3 cubic feet per minute. The maximum designed pressure for this unit is 5 psi. This meter has a 6 digit readout in cubic meters. Additional accuracy is provided for by a circular scale with 10 increments. Each increment indicates 0.005 cubic meters (0.1766 cubic feet). The needle must circle the scale twice for the first digit on the digital readout to increment once (indicating one tenth of a cubic meter).

The readout of these instruments are designed to be accurate only at standard pressure conditions (temperature is compensated for in this unit). Any other conditions cause them to give false readings. The sampling systems are not at standard pressure, and because of this, these instrument do not read true. A special equation must be used if the true totalized flow is desired. This equation is used in emission calculations. The equation is as follows:

$$Qs/Qo = Po/Ps$$

where

Qs = Actual compensated sample volume.
Qo = Operating condition sample volume reading.
Po = Average operating condition sample system vacuum (in Hg).
Ps = Standard atmospheric pressure (29.92 in Hg).

The uncertainty of the values given by this gasmeter in the typically worse case scenario (with the sampling system operated

under a 10" Hg vacuum) can be shown to be normalized to ±0.06 (multiplied by value used - meters, feet, etc). The uncertainty is due to the potential ±2% error of the gasmeter and the ±5% error of the vacuum gauge (see discussion on vacuum gauge below).

Calibration and inspection of the gasmeter has been accomplished on a 6 month basis via Maintenance Engineering Services Calibration Procedure, "Rockwell Type Gas Meter," Calibration Procedure PSCP-4-007. A new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077.

THE PRESSURE OR VACUUM GAUGE measures the vacuum in the system. The air coming from the stacks is first run through the record sample filter paper, then the flow meter and totalizer, and finally the air pump which sucks the air through the system. The more residue collected by sample filter paper the lower the pressure throughout the system. The filter papers are, generally, left in place and replaced on a weekly basis. Over this week, the vacuum within the sampling system increases. This gauge measures this pressure drop and the reading which are recorded are used in emission calculations to acquire the true flow rate (from the rotameter recorded reading) and/or totalized flow (from the gasmeter recorded reading) which was experienced in the sample system during the sample collection period.

The manufacturer states that this gauge has an error of ±2% of span at any point between 25% and 75% of span. In the rest of the scale, an error of ±3% is permissible. These gauges cannot be calibrated so they are replaced if they are found to be reading outside the tolerance limits. Drawing H-2-92490 specifies the following:

Make/Model:	MARSH #J4805
Scape:	30" Hg
Accuracy:	±10% of full scale

The facility instrument number is PI-VV-3. This gauge is scaled in 1 inch increments and should have a readability of ±0.5 inch.

Calibration and inspection of the pressure gauge has been accomplished on a 6 month basis via Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091. Since the vacuum gauge cannot be calibrated, a new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077. This procedure gives instructions to replace this gauge if its tested

accuracy is outside ±5% of scale. This 5% error was chosen for the following reasons:

- The error specified by the manufacturer is at least ±3% and the ±10% specified on the drawing seemed too liberal; especially since the pressure value obtained from this gauge is necessary to compute the true flow rate and the total volume collected.

- It is recognized that use in the field will cause the accuracy of various instruments to wonder beyond the manufacturer's specified limits which are valid when the instrument is brand new.

- The vacuum within the sampling system affects the gas meter measurements more than the rotameter and the ±10% (specified on the drawing - see discussion under gasmeter above) allowable error is desired for the gas meter. See the equations given in the discussion of both the gas meter and the rotameter above.

- An error analysis (with a vacuum gauge error of ±5% of scale) on the gasmeter done with the sampling system at 10" Hg vacuum (typically the worse case) gives an overall error of ±9%. This error includes the ±2% error of the gas meter. This ±9% error is the uncertainty divided by the computed value (see discussion above under gasmeter).

THE FLOW SWITCH (OTHERWISE CALLED THE PRESSURE SWITCH) indicates when the sample flow falls below established limits. The purpose is three fold:

a) To prevent damage to the sample collection filter paper. As the filter paper loads up with particulates, the vacuum increases and the flow drops. If the vacuum increases too much the filter may break through, thus preventing further collection.

b) To prevent nonrepresentative sampling due to anisokinetic sampling. As the flow drops, isokinetic conditions necessary to acquire a representative sample are not kept.

c) To indicate vacuum pump problems (e.g. no flow or failed condition).

The applicable drawing for this instrument is H-2-92490 and it specifies the following:

Make/Model:	CHEM-TEC EQUIP CO MODEL 500-316-BP OR 500-B-BP
CALIBRATED:	To deactivate at 1.0 to 1.5 SCFM Continuity check is required.

The facility instrument number is FSL-VV-3.

Calibration and inspection of the flow switch has been accomplished on a 6 month basis via Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029. A new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077.

THE FLOW REGULATOR adjusts to maintain an established flow within the system. No calibration is required. Drawing H-2-92490 specifies the following:

Make/Model: EBERLINE 10552-C02 RAP-1

The facility instrument number is PCV-VV-3.

VACUUM PUMP INLET FILTER provides filtered air to the pump. This filter should be replaced periodically.

The filters will be cleaned via a new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077.

THE PUMP is a constant flow device. Independent vacuum pumps are provided for each loop of the system (the record sampler, the alpha CAM, and the beta/gamma CAM). The pumps are fitted with twin quick disconnects. In this way each pump can be used as a backup to the others should one of the other pumps fail. The pump do not need calibration. The applicable drawing for this pump is H-2-92490 and it specifies the following:

Make/Model: GAST MODEL NO. 0822-V103-G271X

The Pump shall be oil-less carbon vane rotary pump with inlet and outlet filter/manifold assemblies. Powered by 1/2 HP, 115/230 VAC, 60 Hz, single phase motor.

THE TIMER indicates the length of time the filter paper has been collecting a sample. This information is necessary for emission calculations. The power to the sampling systems is supplied via either switched or unswitch power receptacles. Power is lost to the switched receptacle when the exhauster fan is turned off. The record sampling system, along with this timer is designed to be plugged into the switched receptacle. In this way, this timer will indicate the length of time the exhauster has been running as well. This is important because the sampling system should only be sampling when the exhauster is on. The applicable drawing for this instrument is H-2-92494 and it specifies the following:

Make/Model: CRAMER 10083

Reading: Meter elapsed time resettable 5 digits, reads in hours. First digit reads in tens of an hour.

Accuracy: Certified accurate to ±1%.
Must be calibrated prior to operation.

The manufacturer says (per telecon) that there is no adjustment on this timer, therefore no calibration can be accomplished.

THE CAMS:

The CAM loops (beta/gamma and alpha) within the 296-A-22 stack effluent monitoring system have flow rate indicating and regulating capabilities. A flow rate regulator is provided on each loop to maintain a constant flow rate through the collection filter assembly to compensate for filter loading effects. The CAM systems have local readout count-rate meters and remote recording capability in the control room (on the MCS). Audible and visible alarms, including high airborne radiation, instrument malfunction, and low sample flow indications, are provided locally and on the MCS in the 242-A control room. In addition, high stack radiation and high stack alpha radiation alarms are annunciated on the computer automated surveillance system (CASS). An exhaust alpha monitor failure alarm is also tied to the CASS.

Calibration and inspection of these CAMs are accomplished on an annual basis using the following procedures:

- Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002

- PNL-MA 563, Section 4.2.2, "Eberline Alpha 4, 5, 5A Air Monitors Calibration Procedure."

Also the CAMs are inspected for on a daily, weekly, and monthly basis per Health Physics Procedure 5.2.2.6, Rev 3, "Gaseous Effluent Sampling and Monitoring System Operability Inspection." The filter paper is changed out on a weekly basis per Health Physic Procedure 5.2.2.7, Rev 3 "Operation of Gaseous Effluent Sampling and Monitoring Systems," Health Physics Procedure No. 5.2.2.7, Rev 3. The Health Physic Procedure are contained in WHC, 1992, *Health Physics Procedure Manual*, WHC-IP-0692.

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

"For the vessel vent, flow measurements are accomplished quarterly via Procedure 7-GN-56. There are two ports spaced 90° apart located 24 inches above the sampling probe location on the stack. These ports are 32 inches below the elbow which diverts the stack flow to outside the building. These distances place this location at 3 duct diameter downstream and 4 duct diameters upstream of any flow

disturbances. Measurements are taken in each port at 16 equal annular traverse points (32 in all)."

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

See Appendix G.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

See Appendix G.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

Refer to Section 6.2.3 of the main part of this document.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Refer to Section 7.0 of the main part of this document.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

Refer to Section 8.0 of the main part of this document.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

Refer to Section 9.0 of the main part of this document.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The quality assurance program addressing stack 296-A-22 will be documented in a future quality assurance project plan.

REFERENCES

40 CFR 60, "Standards of Performance of New Stationary Sources," Title 40, *Code of Federal Regulations*, Part 60, as amended, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, as amended, U.S. Environmental Protection Agency, Washington, D.C.

ACGIH, 1989, *Air Sampling Instruments*, American Conference of Governmental Industrial Hygienists, 7th Edition, Cincinnati, Ohio.

AEC, 1974, *Vessel Vent System Arrangement*, Drawing No. H-2-69361, Atomic Energy Commission, Richland Operations Office, Richland, Washington.

ANSI, 1969, *Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility*, ANSI N13.1-1969, American National Standards Institute, New York, New York.

Health Physics Procedure 5.2.2.6.

Procedure 7-GN-56.

"Gaseous Effluent Sampling and Monitoring System Operability Inspection," Health Physics Procedure 5.2.2.6, REV 2, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Eberline Alpha-4, -5, and 5A," Calibration Procedure PSCP-3-003, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Rockwell Type Gas Meter," Calibration Procedure PSCP-4-007, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Air Rotometer," Calibration Procedure PSCP-7-001, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-3, *Management Requirements and Procedures*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-12, *Health Physics Practices Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0692, *Westinghouse Hanford Health Physics Procedures Manual-All Areas*, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX E

METHOD 114 COMPARISON FOR STACK 296-A-40

G. M. Crummel

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APPENDIX E

METHOD 114 COMPARISON FOR STACK 296-A-40

1.0 Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2.0 Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

Plant Documentation

Gelman Sciences, Inter-Office Memorandum to Karol Butcher, October 30, 1991, RE: Versapor 3000, DOP efficiency.

WHC, 1992, *Health Physics Procedure Manual*, WHC-IP-0692

- "Operation of Gaseous Effluent Sampling and Monitoring Systems," Health Physics Procedure No. 5.2.2.7, Rev 3

Response. A 47-mm Versapor* 3000 or equivalent air sample filter is used for the record sampler. This filter is a membrane filter good for collecting 0.3-μm size particles with a collection efficiency of 95.8%.

*Trademark of Gelman Sciences, Inc.

2.2 Radionuclides as Gases.

Plant Documentation:

WHC, 1991, *Health Physics Procedure Manual*, WHC-IP-0692

- "Silver Zeolite Monitor/Change-Out Program At 241-AP Tank Farm," 200 Area Health Physics Procedure No. 5.2.2.4, Rev 0

Response: Silver Zeolite Cartridges are used and are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru.

2.3 Definition of Terms

No response required.

3.0 Radionuclide Analysis Methods

The analysis methods have been evaluated by 222-S Laboratory cognizant personnel and are included as Appendix G.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

For the organizational structure, refer to Section 6.2 of the main part of this document.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-12, Part B, Section 1.14, REV 1, "Alarm Response and Management." Establishes requirements and provides guidance for responding to alarms that are the responsibility of Health Physics (HP).

WHC-CM-4-12, Part A, Section 2.1, REV 0, "Radiological Problem Reporting Program." The purpose of the radiological problem report program is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Part B, Section 12.1, REV 1, "Emergency Response." An emergency is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To be able to perform this function, HP personnel receive training to respond to a variety of emergency situations. Procedures for HPs (WHC-CM-4-12 and WHC-IP-0692) are written to provide guidelines to respond to emergencies. Together, the training and the written procedures detail the HP emergency response program.

Emergency Response. The HP personnel are, in many situations, the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by (1) personnel observing the event, (2) alarms, (3) the Patrol Operation Center, or (4) the Emergency Control Center(s) once they are manned. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person, such as a firefighter or patrol officer. A rapid response is required; however, no undue risks should be taken nor should employee safety be compromised. The type of emergency determines the level of planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route, etc.) and approval of the Building or Facility Emergency Director is necessary to re-enter.

Although HP personnel respond to an emergency using basic guidelines, an area or facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 12.1.2.1, REV 0, "OHP Response to Double-Shell/Aging Waste Tank Pressurization Alarm." This procedure establishes the method of Operational Health Physics (OHP) response to tank pressurization alarms on double-shell or aging waste tanks. This procedure describes the steps and material necessary to respond to, and perform investigative surveys after, tank pressurization alarms.

WHC-IP-0692, Section 12.1.2.3, REV 2, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, effluent exhaust CAM systems. This procedure describes the steps and material necessary to exchange, perform field concentration calculations, and submit suspect samples for "rush" or "Red Envelope" analysis, when responding to alarms on effluent exhaust CAM systems.

WHC-IP-0692, Section 12.1.6, REV 2, "Stack Effluent Release Response." This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks. This procedure describes the immediate actions to respond to an exhaust (CAM) stack alarm (i.e., CAM monitoring downstream or upstream of the final filtration).

WHC-IP-0692, Procedure No. 12.2.1, REV 2, "Emergency Response Air Sampling." This procedure establishes the instruction and guidelines for air sampling in an emergency situation. This procedure describes the steps for air sampling both inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, REV 0, "Health Physics Emergency Response Team." This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team and the HP Technicians Field Survey Teams. This procedure describes the steps for an initial emergency response by the HP Emergency Response Team (ERT) and HP Technicians Field Survey Teams. The HP ERT and the HP Technicians Field Survey Teams may be requested to respond to an emergency when it is deemed that an environmental release of radioactive material may extend beyond the control of a facility or outside the boundaries of the Hanford Site. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, REV 2, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a radioactive beta-gamma plume created from a radioactive material release to the environment and determine if it is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or hazardous materials are reported via instruction given in WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, Section 1.22, "Tank Farms Occurrence Reporting and Processing of Operations Information." The purpose of this procedure is to establish and implement specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences at the tank farms, as required by WHC-CM-1-3, MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 A description of the sample collection and analysis procedures used in measuring the emission, including where applicable:

4.3.1 -- Identification of sampling sites and number of sampling points, including the rational for site selection.

The 241-A-40 stack measures 25.4 cm (10 in.) in diameter. The sample probe assembly is located 2.4 m (8 ft) above the fan discharge point into the stack and 50.8 cm (20 in.) below the top of the stack. The closest flow disturbances are approximately

9.6 stack diameters downstream (the fan discharge point) and two stack diameters upstream (the top of stack).

There are two nozzles on this probe. This is as recommended in ANSI N13.1-1969, Appendix A, Section A3.2 (ANSI 1969), for this size stack, 25.4 cm (10 in.).

4.3.2 -- A description of the sampling probes and representativeness of the samples.

The sample probe consists of two inlets that point down into the upflowing gas. Each inlet is approximately centered in each of the two equal annual areas. This is shown on drawing H-2-91245. It is easily shown (from Table A1, ANSI N13.1-1969, and from information on the stack flow rate) that the flow within the stack is highly turbulent resulting in a uniform velocity distribution across the cross-sectional area of the stack. As stated in ANSI N13.1-1969, Appendix A, Section A3.3.2, "as the flow becomes more turbulent, the velocity becomes more nearly uniform across the duct." Based on this it can be shown that the sampling probe is isokinetic. See discussion in Section 4.3.6.

4.3.3 -- A description of any continuous monitoring systems used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable; emissions are not monitored continuously for compliance demonstration. See discussion in Section 4.3.6.

4.3.4 -- A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The radionuclides are collected through the probe discussed in Section 4.3.1 above. Gaseous radionuclides are collected with silver zeolite cartridges that are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. The gross filter efficiency of a silver zeolite is based on the particular absorbed/adsorbed radionuclide being evaluated and the porosity of the filter. For uses at the Hanford Site (i.e., ruthenium, iodine), the efficiency is 99.2 to 99.98 (taken from Table O-2 of *Air Sampling Instruments*, American Conference of Governmental Industrial Hygienists, seventh edition [ACGIH 1989]).

The silver zeolite cartridges are exchanged as follows:

- When the cartridges have been in the sample for 1 week
- When radiation readings indicate a buildup of greater than 16 mrem/hour within the last 8 hours
- When requested by operations management.

Particulate radionuclides are collected with a record sampler. The record sampler uses a 47-mm Versapor* 3000 or equivalent air sample

filter for the record sampler. This membrane filter collects 0.3 μm size particles with a collection efficiency of 91%.

If at all possible, record air samples are left running for a full 168-hour (7-day) week to ensure a representative sample.

4.3.5 -- A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis, calibration procedures and frequency of calibration.

See Appendix G.

4.3.6 -- A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

The sample collection and monitoring system consist of a record sampler, two silver zeolite cartridges, and one Continuous Air Monitors (CAM). The record sample and silver zeolite portion of the sampling system is considered the regulatory portion of the system. The record sampler and silver zeolite cartridges provide the basis for reporting the amount and concentration of radionuclides released to the environment. The generated reports are forwarded to all appropriate organizations and agencies. The CAM is considered operational safety devices and is set to alarm if emissions are detected above preset levels. The difference between the CAM and the record sampler is the fact that there is a radiation detector above or near the collection filter within the CAM. The record sampler contains only a collection filter. If the filter paper of the record sampler is not useable for some reason when it is exchanged for analysis, the filter paper from the CAM could be used instead. For this reason the CAM may be considered as a regulatory backup device. The detector portion (and the associated electronics) of the CAM is not considered regulatory.

The sampling system is designed with two identical sampling probes mounted side by side in the same horizontal plane. One probe routes its sample to the record sampler (the silver zeolite cartridges are installed just after the record sampler). The other probe routes the sample to a beta/gamma CAM.

This sampling system is designed to be isokinetic by sizing the stack's sampling probe to both, a specified sample flow rate and on measured average stack flow rates. For most of Tank Farms the record sampling portion of the sampling system is designed to a 2.2 CFM flow rate. Historically, the 2.2 CFM rate was selected to represent the respiration rate of the "average" worker. A lower flow rate of 2.0 CFM is allowed for the CAMs. However, the design was still for 2.2 CFM. The lower flow rate (2 CFM) theoretically results in the CAMs oversampling the stream. Since CAMs are monitoring devices which provide for notification of increasing particulate radionuclide emissions, this oversampling concept provides for a sort of early warning signal. Somehow, though, over the years the 2 CFM setting for the CAMs has been interpreted to apply to the record samplers as well. Now 2 CFM is the nominally

expected setting. The entire sampling collection and monitoring system is considered to consists of the following elements:

- The sampling probe which withdraws the sample from the stack.
- The sample transport line which transports the sample to a sample collection and/or other detection devices.
- The collection and/or detection devices.
- The rotameter which measures the flow through the system.
- The gasmeter or totalizer which totals the sample flow.
- The pressure or vacuum gauge which measures the vacuum in the system.
- The flow switch (also called the pressure switch) indicates when the sample flow falls below established limits.
- The flow regulator which adjusts to maintain an established flow rate within the system.
- The vacuum pump which supplies the flow through the system.
- The timer which indicates the length of time the collection devices have been collecting a sample.

Each of these elements are discussed in further detail below.

THE STACK'S SAMPLING PROBE AND SAMPLE TRANSPORT LINE: The sampling probes withdraw samples from the stack section. The probes are located 8 feet above the fan discharge ducts of the fan and 20 inches below the top of the stack. The sampler probe incorporates the use of two nozzles for sampling the stack flow (reference drawing H-2-91245). At the designed flow rate of 2.2 CFM the nozzles are sized to be isokinetic at an actual stack flow rate of 980 CFM. A further analysis is given under the rotameter discussion below.

The sample transport line was selected and installed in a manner designed to minimize particle loss attributed to gravity settling, turbulent impaction, and electrostatic effects. The run lengths, bend radii, and tube transition severity of the sample transport line are minimized to the extent practical. This line extends from the sample probe down to the top of the instrument cabinet for an approximate length of 13.5 feet. The line contains a single 90° bend designed with bend radius of not less than 10 inches. The line is sized to 3/4" OD by 0.065" WALL. The sample transport line is heat traced (operating at 43 °C [110 °F]) to inhibit condensation of moisture and resultant sample flow retardation by maintaining the temperature above the dew point.

THE RECORD SAMPLE COLLECTION FILTER PAPER AND HOLDER: The record sample collection filter paper collects particulate radionuclides from the stack or stream. The filter used is a Gelman Sciences Versapor 3000 - Supported Membrane type. The manufacturer specifies that this filter has a 91% collection efficiency for 0.3 micron particles (reference Gelman Sciences, Inter-Office Memorandum to Karol Butcher, October 30, 1991, RE: Versapor 3000, DOP efficiency).

The make/model of the filter holder is BGI INC FI (reference drawing H-2-92489). The record sample holder is described as follows:

- Large outside diameter with knurled outer ring for ease of opening.
- Rubber "O" ring gaskets used to seal the sample holder.
- Fine mesh screen behind the sample filter to keep the sample a constant distance from the inlet.

The holder is inspected for wear and leaks on a daily, weekly, and monthly basis per Health Physics Procedure 5.2.2.6, Rev 3, "Gaseous Effluent Sampling and Monitoring System Operability Inspection." The filter paper is exchanged on a weekly basis per Health Physic Procedure 5.2.2.7, Rev 3 "Operation of Gaseous Effluent Sampling and Monitoring Systems," Health Physics Procedure No. 5.2.2.7, Rev 3. The Health Physic Procedure are contained in WHC, 1992, *Health Physics Procedure Manual*, WHC-IP-0692.

THE SILVER ZEOLITE CARTRIDGE: Directly after the record sampler, the flow passes through two silver zeolite cartridge filters. These filters collect volatile radionuclides. Silver zeolite filters are designed to collect ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{103}Ru, and ^{106}Ru. The cartridge filters are exchanged weekly and sent to the laboratory for analysis per Health Physics procedure No. 5.2.2.4, Rev 0, "Silver Zeolite Monitor/Change-Out Program At 241-AP Tank Farm."

THE ROTAMETER measures the flow rate through the sampling system. The rotameter consists of a ball floating in a column of fluid (air) in a tube. There is no calibration. This model has neither flow adjustment nor calibration scale adjustment. The manufacturer states: "...If used in the proper application, with an acceptable media, the flowmeter will give a lifetime of service without the need for calibration" (reference DWYER INSTRUMENTS, INC letter to WHC, addressed to Jeff Summerhays, dated September 28, 1992). The manufacturer mentions checking calibration only in the shop with a certified air flow device. The operating instructions state "DO NOT attempt to check the Dwyer Rate-Master Flowmeters with a similar flowmeter as seemingly unimportant variations in piping and back pressure may cause noticeable differences in the indicated reading..." (CVI file 20553, dated August 14, 1980).

The applicable drawing for this rotameter is H-2-92489 and it specifies the following:

Make/Model:	DWYER/RMC-103PF
Scale:	10" SCALE, 20 - 200 SCFH
Accuracy:	±10% AT 2.2 SCFM

This instrument is scaled in units of 5 SCFH (0.08 SCFM) and is readable to ±2.5 SCFH (0.04 SCFM). This instrument is designed to operate in pressures up to 35 psi and in temperatures up to 130 °F. However, the readout is designed to be accurate only at standard condition of pressure and temperature. Under any other conditions the rotameters give false readings unless compensated for using appropriate equations. The sampling systems are not at standard pressure, and because of this these instruments do not read true. A special square root function (equation) must be used if the true flow rate is desired. The literature (United States Nuclear Regulatory Commission Office of Inspection and Enforcement, Washington D.C. 20555, dated December 16, 1982, IE Information Notice No. 82-49: CORRECTION FOR SAMPLE CONDITIONS FOR AIR AND GAS MONITORING) gives this equation as:

$$Qs/Qo = Ks/Ko*[(Po*Ts)/(Ps*To)]^{½}$$

where

Qs = Actual compensated sample flow rate.
Qo = Operating condition sample flow reading of the rotameter.
Po = Operating condition sample system vacuum value in inches Hg.
Ps = Standard atmospheric pressure (29.92 inches Hg).
To = Operating condition temperature (°K).
Ts = Standard temperature (294 °K).
Ks = The width of the rotameter chamber in which the ball floats divided by the width of the ball floating in the chamber.
Ko = A function of the operating conditions which may be determined experimentally.

The manufacturer states that the Ks/Ko value is one (per telecon). Apparently this instrument is designed so that these two variables cancel each other out.

A similar equation to that given above is used in emission calculations. However, temperature values are not used. The literature claims that only a ±5% error results if temperature compensations are ignored between 24 and 116 °F. This is the case at Hanford since the emission calculations only compensate for the pressure readings. Typically the operating temperature of the sampling systems can be assumed to be at 110 °F. This is the temperature that the sample transfer line heat tracing is designed to operate at. Accordingly a more exact error* on the rotameter reading due to temperature can be computed to be approximately +4%.

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* Error is defined as positive if Qo is greater that Qs.

The literature claims that flow rate readings from a rotameter are accurate to ±5% if temperature and pressure are taken into account. The rotameter readings are not compensated in the field. This means that the sample which is collected may not be as representative as it could be. The following example is given to evaluate this:

The equation above is used to calculate what the actual flow rate in the sampling system would be under a typically worse case scenario. In this scenario the system has been adjusted to give a rotameter indication of 2.0 CFM. The following assumptions are used:

- Typically worse vacuum in the system is not greater than 10 inches Hg.
- It was also mentioned that the heat trace is designed to operate at 110 °F = 316 °K.

$Qs = 2.0\{[(29.92 - 10)294]/[(29.92)(316)]\}^{½} = 1.57$ CFM with an uncertainty of ± 0.14 CFM or the actual flow rate is from 1.71 to 1.44 CFM.

The uncertainty is due to the ±5% error of the rotameter and the ±5% error of the vacuum gauge (see discussion on vacuum gauge below).

This next example is given to evaluate the efficiency of this system from recent real data:

The latest stack flow measurement was accomplished on 02/08/93 per work package # 2E-92-01446. The flow was measured to be 867 CFM. The vacuum in this system during the 1992 time frame averaged 4" Hg. Assuming the sample flow is set to the nominal 2 CFM flow rate and using the equation above gives an actual sample flow rate of 1.80 CFM. This 1.80 CFM sample flow rate computes to an isokinetic stack flow rate at 800 CFM. This actual sample flow rate result can be shown to result in oversampling by less than 1% for 12 micron sized particles (reference Table C1 in ANSI N13.1-1969).

Calibration and inspection of the rotameter has been accomplished, in the past, on a 6 month basis via Maintenance Engineering Services Calibration Procedure, "Air Rotameter," Calibration Procedure # PSCP-7-001. Since the manufacturer, as well as the CVI file (discussed above), indicates that calibration of this instrument is not necessary, a new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077.

THE GASMETER OR TOTALIZER totals the flow through the sampling system. This Gasmeter use to be made by Rockwell but they sold this product line to Equimeter. This totalizer complies with ANSI-ASC B109.1 specifications which states that a meter must remain within ±2.0% accuracy at 1,000,000 cubic feet. This is basically the same

system used on homes across the country. The manufacturer supplied data shows that this meter is well within the required accuracy (the regulations specify the accuracy to be within 2%). In fact the data supplied showed this meter to be as accurate to -0.4% at the maximum designed full rate and to +0.2% accurate at 20% of the maximum designed full flow rate for an average volume of 100,000 cubic feet (letter from Equimeter to WHC, addressed to Jeff Summerhays).

The manufacturer is confident that the totalizer can operate for 20 years or more if a clean gas is passed, and the unit is not over pressurized (exceed the maximum flow rate). Over-pressurization would hasten the aging process. The years of residential service referred to here assume approximately 100,000 cubic feet of flow per year (2 million cubic feet in 20 years). Assuming the Vessel Vent systems operates 24 hours a day at approximately 120 cubic feet per hour, it will pass 2,000,000 cubic feet of air in 694 days (approximately 1.9 years).

This gasmeter was also evaluated in WHC-SD-GN-ES-001, "200 Area - Stack Gas Record Sample Flowmeter." This document states that the useful life of this unit appears to be from one to two years when it is not used in a wet and corrosive environment. When used in a wet and corrosive environment, the failure rate is reported to be from 3 to 6 months.

If this meter goes out of tolerance, the main problem, according to the manufacturer, is wear on the moving parts. When this happens the meters should be replaced. A replacement kit is available for this purpose and can be installed if the meter is found out of calibration.

The applicable drawing for this instrument is H-2-92489 and it specifies the following:

Make/Model:	ROCKWELL MR-9, <u>temperature corrected</u>
Accuracy:	±10% AT 2.2 SCFM

The MR-9 model number relates to the maximum flow for which this gas meter is designed. The 9 can be interpreted as 9 cubic meters per hour. This converts to approximately 5.3 cubic feet per minute. The maximum designed pressure for this unit is 5 psi. This meter has a 6 digit readout in cubic meters. Additional accuracy is provided for by a circular scale with 10 increments. Each increment indicates 0.005 cubic meters (0.1766 cubic feet). The needle must circle the scale twice for the first digit on the digital readout to increment once (indicating one tenth of a cubic meter).

The readout of these instruments are designed to be accurate only <u>at standard pressure conditions</u> (temperature is compensated for in this unit). Any other conditions cause them to give false readings. The sampling systems are not at standard pressure, and because of this, these instrument do not read true. A special equation must be used

if the true totalized flow is desired. This equation is used in emission calculations. The equation is as follows:

$$Qs/Qo = Po/Ps$$

where

Qs = Actual compensated sample volume.
Qo = Operating condition sample volume reading.
Po = Average operating condition sample system vacuum (in Hg).
Ps = Standard atmospheric pressure (29.92 in Hg).

The uncertainty of the values given by this gasmeter in the typically worse case scenario (with the sampling system operated under a 10" Hg vacuum) can be shown to be normalized to ±0.06 (multiplied by value used - meters, feet, etc). The uncertainty is due to the potential ±2% error of the gasmeter and the ±5% error of the vacuum gauge (see discussion on vacuum gauge below).

Calibration and inspection of the gasmeter has been accomplished on a 6 month basis via Maintenance Engineering Services Calibration Procedure, "Rockwell Type Gas Meter," Calibration Procedure PSCP-4-007. A new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077.

THE PRESSURE OR VACUUM GAUGE measures the vacuum in the system. The air coming from the stacks is first run through the record sample filter paper, then the flow meter and totalizer, and finally the air pump which sucks the air through the system. The more residue collected by sample filter paper the lower the pressure throughout the system. The filter papers are, generally, left in place and replaced on a weekly basis. Over this week, the vacuum within the sampling system increases. This gauge measures this pressure drop and the reading which are recorded are used in emission calculations to acquire the true flow rate (from the rotameter recorded reading) and/or totalized flow (from the gasmeter recorded reading) which was experienced in the sample system during the sample collection period.

The manufacturer states that this gauge has an error of ±2% of span at any point between 25% and 75% of span. In the rest of the scale, an error of ±3% is permissible. These gauges cannot be calibrated so they are replaced if they are found to be reading outside the tolerance limits. Drawing H-2-92490 specifies the following:

Make/Model:	MARSH #J4805
Scape:	30" Hg
Accuracy:	±10% of full scale

This gauge is scaled in 1 inch increments and should have a readability of ±0.5 inch.

Calibration and inspection of the pressure gauge has been accomplished on a 6 month basis via Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091. Since the vacuum gauge cannot be calibrated, a new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077. This procedure gives instructions to replace this gauge if its tested accuracy is outside ±5% of scale. This 5% error was chosen for the following reasons:

- The error specified by the manufacturer is at least ±3% and the ±10% specified on the drawing seemed too liberal; especially since the pressure value obtained from this gauge is necessary to compute the true flow rate and the total volume collected.

- It is recognized that use in the field will cause the accuracy of various instruments to wonder beyond the manufacturer's specified limits which are valid when the instrument is brand new.

- The vacuum within the sampling system affects the gas meter measurements more than the rotameter and the ±10% (specified on the drawing - see discussion under gasmeter above) allowable error is desired for the gas meter. See the equations given in the discussion of both the gas meter and the rotameter above.

- An error analysis (with a vacuum gauge error of ±5% of scale) on the gasmeter done with the sampling system at 10" Hg vacuum (typically the worse case) gives an overall error of ±9%. This error includes the ±2% error of the gas meter. This ±9% error is the uncertainty divided by the computed value (see discussion above under gasmeter).

THE FLOW SWITCH (OTHERWISE CALLED THE PRESSURE SWITCH) indicates when the sample flow falls below established limits. The purpose is three fold:

a) To prevent damage to the sample collection filter paper. As the filter paper loads up with particulates, the vacuum increases and the flow drops. If the vacuum increases too much the filter may break through, thus preventing further collection.

b) To prevent nonrepresentative sampling due to anisokinetic sampling. As the flow drops, isokinetic conditions necessary to acquire a representative sample are not kept.

c) To indicate vacuum pump problems (e.g. no flow or failed condition).

The applicable drawing for this instrument is H-2-92490 and it specifies the following:

Make/Model: CHEM-TEC EQUIP CO MODEL 500-316-BP OR 500-B-BP

CALIBRATED: To deactivate at 1.0 to 1.5 SCFM
Continuity check is required.

Calibration and inspection of the flow switch has been accomplished on a 6 month basis via Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029. A new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077.

THE FLOW REGULATOR adjusts to maintain an established flow within the system. No calibration is required. Drawing H-2-92490 specifies the following:

Make/Model: EBERLINE 10552-C02 RAP-1

VACUUM PUMP INLET FILTER provides filtered air to the pump. This filter should be replaced periodically.

The filters will be cleaned via a new system functional test/calibration procedure has been developed which, when completed and released (after appropriate approval) will be used to check the entire sampling system at the same time. The number of this new procedure is 6-TF-077.

THE PUMP is a constant flow device. Independent vacuum pumps are provided for each loop of the system (the record sampler, the alpha CAM, and the beta/gamma CAM). The pumps are fitted with twin quick disconnects. In this way each pump can be used as a backup to the others should one of the other pumps fail. The pump do not need calibration. The applicable drawing for this pump is H-2-92490 and it specifies the following:

Make/Model: GAST MODEL NO. 0822-V103-G271X

The Pump shall be oil-less carbon vane rotary pump with inlet and outlet filter/manifold assemblies. Powered by 1/2 HP, 115/230 VAC, 60 Hz, single phase motor.

THE TIMER indicates the length of time the filter paper has been collecting a sample. This information is necessary for emission calculations. The power to the sampling systems is supplied via either switched or unswitch power receptacles. Power is lost to the switched receptacle when the exhauster fan is turned off. The record sampling system, along with this timer is designed to be plugged into the switched receptacle. In this way, this timer will indicate the length of time the exhauster has been running as well.

This is important because the sampling system should only be sampling when the exhauster is on. The applicable drawing for this instrument is H-2-92494 and it specifies the following:

Make/Model: CRAMER 10083

Reading: Meter elapsed time resettable 5 digits, reads in hours. First digit reads in tens of an hour.

Accuracy: Certified accurate to ±1%.
Must be calibrated prior to operation.

The manufacturer says (per telecon) that there is no adjustment on this timer, therefore no calibration can be accomplished.

THE CAMS:

The CAM (beta/gamma) within the 296-A-40 stack effluent monitoring system has flow rate indicating and regulating capabilities. A flow rate regulator is provided to maintain a constant flow rate through the collection filter assembly to compensate for filter loading effects. The CAM systems have local readout count-rate meters. Audible and visible alarms, including high airborne radiation, instrument malfunction, and low sample flow indications, are provided. In addition, high stack radiation and high stack alpha radiation alarms are annunciated on the computer automated surveillance system (CASS). An exhaust alpha monitor failure alarm is also tied to the CASS.

Calibration and inspection of these CAMs are accomplished on an annual basis using the following procedures:

- Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002

- PNL-MA 563, Section 4.2.2, "Eberline Alpha 4, 5, 5A Air Monitors Calibration Procedure"

Also the CAMs are inspected for on a daily, weekly, and monthly basis per Health Physics Procedure 5.2.2.6, Rev 3, "Gaseous Effluent Sampling and Monitoring System Operability Inspection." The filter paper is changed out on a weekly basis per Health Physic Procedure 5.2.2.7, Rev 3 "Operation of Gaseous Effluent Sampling and Monitoring Systems," Health Physics Procedure No. 5.2.2.7, Rev 3. The Health Physic Procedure are contained in WHC, 1992, *Health Physics Procedure Manual*, WHC-IP-0692.

4.3.7 A description of effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

Flow measurements are taken quarterly via Procedure 7-GN-56. These measurements are taken from a single port located 20 inches above a

one foot deep stack flow straightener. The flow straightener section begins 14 inches above the fan discharge ducts of the fans. Measurements are taken in each port at 16 equal annular traverse points.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy, and completeness of the emission measurement data including a description of the procedures used to assess these parameters.

See Appendix G.

4.5 The quality control program shall evaluate and track the quality of the emission measurement data against preset criteria. The program should include, where applicable, a system of replicates; spiked samples; split samples; blanks; and control charts. The number and frequency of such quality control checks shall be identified.

See Appendix G.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sampling collection, analysis, and reporting system. Sample handling and preservation procedures shall be established to maintain integrity of the samples during collection, storage, and analysis.

Refer to Section 6.2.3 of the main part of this document.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Refer to Section 7.0 of the main part of this document.

4.8 A corrective action program shall be established including criteria for when corrective actions will be taken and who is responsible for taking the corrective action.

Refer to Section 8.0 of the main part of this document.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emission measurements program. These reports should include assessment of the quality of the data, results of audits, and description of corrective actions.

Refer to Section 9.0 of the main part of this document.

REFERENCES

Procedure 7-GN-56

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, as amended, U.S. Environmental Protection Agency, Washington, D.C.

ACGIH, 1989, *Air Sampling Instruments*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

ANSI, 1969, *Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility*, ANSI N13.1-1969, American National Standards Institute, New York, New York.

"Gaseous Effluent Sampling and Monitoring System Operability Inspection," Health Physics Procedure 5.2.2.6, REV 2, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Eberline Beta Air Monitor, Models AMS-3, AMS-3A, And 700300," Calibration Procedure PSCP-3-002, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Eberline Alpha-4, -5, and 5A," Calibration Procedure PSCP-3-003, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Rockwell Type Gas Meter," Calibration Procedure PSCP-4-007, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Pressure and Vacuum Gauges," Calibration Procedure PSCP-4-091, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Chem-Tec Adjustable Flow Switch Model 500," Calibration Procedure PSCP-6-029, Westinghouse Hanford Company, Richland, Washington.

Maintenance Engineering Services Calibration Procedure, "Air Rotometer," Calibration Procedure PSCP-7-001, Westinghouse Hanford Company, Richland, Washington.

RL and RHO, 1984, *Quality Assurance Level I, KI Primary Tank 10 Exhaust Stack Probe Assembly*, Drawing No. H-2-91245, U.S. Department of Energy-Richland Operations Office and Rockwell Hanford Operations, Richland, Washington.

WHC-CM-1-3, *Management Requirements and Procedures*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-12, *Health Physics Practices Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-7, *Tank Farms, Grout, and Solid Waste Management Administration Manual*, as amended, Westinghouse Hanford Company, Richland, Washington.

WHC-IP-0692, *Westinghouse Hanford Health Physics Procedures Manual-All Areas*, Westinghouse Hanford Company, Richland, Washington.

APPENDIX F

METHOD 114 COMPARISON FOR STACK 340-NT-EX

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APPENDIX F

METHOD 114 COMPARISON FOR STACK 340-NT-EX

METHOD 114-TEST METHODS FOR MEASURING
RADIONUCLIDE EMISSIONS FROM STATIONARY SOURCES

1.0 Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

2.0 Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will
be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

The facility uses WHC-IP-0692, *Health Physics Procedures Manual*, Section 5.2.3.1, "Air Sample Exchange," for direction in choosing filter media (WHC 1991a). This procedure requires use of a 3-μm particle rated LB5211 or equivalent fiberglass filter. The 340 Facility currently uses Gelman Sciences, Inc., 3 μm Versapor 3000* size 47-mm filters. Although listed as 3 μm filters, in a letter provided by Gelman Sciences, these filters have shown a 91% efficiency rating for particles of size 0.3 μm using ASTM D 2986-71 Method (Gelman Sciences).

2.2 Radionuclides as Gases.

Samples are exchanged weekly as required by Health Physics Scheduled Radiation Survey Task Description for Building 340, Task No. J-W005, (WHC 1993). Procedure 5.2.3.1, "Air Sample Exchange," found in WHC-IP-0692, *Health Physics Procedures Manual*, provides the detailed instruction of how to accomplish a changeout (WHC 1993). This

*Trademark of Gelman Sciences, Inc.

procedure discusses the use of charcoal cartridges used at the 340 Facility to sample radioactive iodine.

2.2.1 The Radionuclide Tritium (H-3). Tritium in the form of water vapor is collected from the extracted effluent sample by sorption, condensation or dissolution techniques. Appropriate collectors may include silica gel, molecular sieves, and ethylene glycol or water bubblers.

Tritium in the gaseous form may be measured directly in the sample stream using Method 8-1, collected as a gas sample or may be oxidized using a metal catalyst to tritiated water and collected as described above.

Vault storage tanks get their radioactivity from the waste sent to the facility by Pacific Northwest Laboratory (PNL). Work in the laboratories is not routine, instead varying with each project. Constituent type and volume received at the 340 Facility also varies with each project. Recently, PNL has been working with tritium. To date, the 340 Facility has not evaluated the need to implement monitoring of tritium in the stack effluent.

2.2.2 Radionuclides of Iodine. Iodine is collected from an extracted sample by sorption or dissolution techniques. Appropriate collectors may include charcoal, impregnated charcoal, metal zeolite and caustic solutions.

Vault storage tanks get their radioactivity from the waste sent to the facility by PNL. Work in the laboratories is not routine, instead varying with each project. Constituent type and volume received at the 340 Facility also varies with each project. In the past, PNL worked with large quantities of radioactive iodine. Although this is no longer the case, the 340 Facility continues to monitor for radioactive iodine using HI-Q Environmental Products, TEDA-Impregnated Carbon Cartridge for Adsorption of Radioactive Iodine.

2.2.3 Radionuclides of Argon, Krypton and Xenon. Radionuclides of these elements are either measured directly by an in-line or off-line monitor, or are collected from the extracted sample by low temperature sorption techniques, Appropriate sorbers may include charcoal or metal zeolite.

Vault storage tanks get their radioactivity from the waste sent to the facility by PNL. Work in the laboratories is not routine, instead varying with each project. Constituent type and volume received at the 340 Facility also varies with each project. Currently, PNL does not use radioactive argon, krypton, or xenon in any projects.

2.2.4 Radionuclides of Oxygen, Carbon, Nitrogen and Radon. Radionuclides of these elements are measured directly using an in-line or off-line monitor. Radionuclides of carbon in the form of carbon dioxide may be collected by dissolution in caustic solutions.

Vault storage tanks get their radioactivity from the waste sent to the facility by PNL. Work in the laboratories is not routine, instead varying with each project. Constituent type and volume received at the 340 Facility also varies with each project. Currently, PNL does not use radioactive oxygen, nitrogen, or radon in any projects.

2.3 Definition of Terms

In-line monitor means a continuous measurement system in which the detector is placed directly in or adjacent to the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2 and G-4.

Off-line monitor means a measurement system in which the detector is used to continuously measure an extracted sample of the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2 and G-4.

Sample collection means a procedure in which the radionuclides are removed from an extracted sample of the effluent using a collection media. These collection media include filters, absorbers, bubblers and condensers. The collected sample is analyzed using the methods described in Section 3.0.

3.0 Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are described which are applicable to the analysis of radionuclides collected from airborne effluent streams at stationary sources. These methods are applicable only under the conditions stated and within the limitations described. Some methods specify that only a single radionuclide be present in the sample or the chemically separated sample. This condition should be interpreted to mean that no other radionuclides are present in quantities which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining the activity of any alpha-emitting radionuclide, regardless of what other radionuclides are present in the sample provided the chemical separation step produces a very thin sample and removes all other radionuclides which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

3.1.2 Method A-2, Radiochemistry-Alpha Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It may also be applicable for determining compliance, when other radionuclides of the separated element are present, provided that the calculated emission rate is assigned to the radionuclide which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

3.1.3 Method A-3, Direct Alpha Spectrometry.

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM) or better, ASTM-D-3084(16).

3.1.4 Method A-4, Direct Alpha Counting (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determination may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, or the identity and isotopic ratio of the radionuclides in the sample are well known, and (2) measurements using either Method A-1, A-2 or A-5 have shown that this method provides a reasonably accurate measurement of the emission rate. Gross alpha measurements are applicable to unidentified mixtures of radionuclides only for the purposes and under the conditions described in Section 3.7. APHA-601(3), ASTM-D-1943(10).

3.1.5 Method A-5, Chemical Determination of Uranium.

Uranium: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E318(15), ASTM-D-2907(14).

3.1.6 Method A-6, Radon-222-Continuous Gas Monitor.

Principle: Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

Applicability: This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

Principle: Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is corrected to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

Applicability: Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon 220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

3.2 Methods for Gaseous Beta Emitting Radionuclides.

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for measuring the activity of a gaseous beta emitting radionuclide in an effluent stream that is suitable as a counting gas, when no other beta-emitting nuclides are present. DOE/EP-0096(1 7), NCRP-58(23).

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

Principle: The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

Applicability: This method is applicable only to radionuclides with maximum beta particle energies greater then 0.2 MeV. This method may be used to measure emissions of specific radionuclides only when it is known that the sample contains only a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. Specific radionuclide analysis of periodic grab samples may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in Section 3.7.

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides.

3.3.1 Method B-3, Radiochemistry-Beta Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for measuring the activity of any beta-emitting radionuclide, with a maximum energy greater than 0.2 MeV, provided no other radionuclide is present in the separated sample. APHA-608(5).

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: Gross beta measurements are applicable only to radionuclides with maximum beta particle energies greater than 0.2 MeV. Gross beta measurements may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, and (2) measurements made using Method B-3 show reasonable agreement with the gross beta measurement. Gross beta measurements are applicable to mixtures of radionuclides only for the purposes and under the conditions described in Section 3.7. APHA-602(4), ASTM-D-1890(11).

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to any beta-emitting nuclide when no other radionuclide is present in the sample or the separated sample provided that it can be incorporated in the scintillation cocktail. This method is also applicable for samples which contain more than one radionuclide but only when the energies of the beta particles are sufficiently separated so that they can be resolved by the spectrometer. This method is most applicable to the measurement of low-energy beta emitters such as tritium and carbon-14. APHA.609(6), EML LV-539-17(19).

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1. High Resolution Gamma Spectrometry.

Principle: The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It can be applied to complex mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gases. The method may also be applied to the analysis of gaseous gamma emitting radionuclides directly in an effluent stream by passing the stream through a chamber or cell containing the detector. ASTM-3649(9), IDO-12096(18).

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 keV. It can be applied only to relatively simple mixtures of gamma emitting radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It is not applicable to mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector.

3.4.4 Method G-4, Gross Gamma Counting.

Principle: The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

Applicability: Gross gamma measurements may be used to measure emissions of specific radionuclides only when it is known that the sample contains a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This method may be applied to analysis of gaseous radionuclides directly in an effluent stream by placing the detector directly in or adjacent to the effluent stream or passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

3.5 Counting Methods. All of the methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

▪ Gas Flow Proportional Counters. The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

▪Scintillation Counters. The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

▪Solid-State Counters. Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

▪Alpha Spectrometers. Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

3.5.2 Beta Counting:

▪Ionization Chambers. These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

▪Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters. The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

▪Scintillation Counters. The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

▪Liquid Scintillation Spectrometers. Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

3.5.3 Gamma Counting:

▪Low-Resolution Gamma Spectrometers. The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

▪High-Resolution gamma Spectrometers. Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

▪Single Channel Analyzers. Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which hove the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in Section 3.1 through 3.4 may be used.

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured

concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

See Appendix H.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

WHC-CM-4-12, Part B, Section 1.14, "Alarm Response and Management." Establishes requirements and provides guidance for responding to alarms that are the responsibility of Health Physics (HP).

WHC-CM-4-12, Part A, Section 2.1, "Radiological Problem Reporting Program." The purpose of the Radiological Problem Report (RPR) program is to provide a documented record of observed radiological problems, a mechanism for reporting these problems to management for action, a capability to track and monitor the progress of the planned corrective actions, and a database for assessing trends in radiological program performance and needed actions.

WHC-CM-4-12, Part B, Section 12.1, "Emergency Response." An Emergency is a sudden unexpected event requiring immediate response to mitigate impacts to people, property, or the environment. When radioactive material is involved, Health Physics (HP) plays a major role in evaluating, controlling, and recovering from the event. To perform this function, HP personnel receive training to respond to a variety of emergency situations. All HP procedures provide emergency response guidelines. Together, the training and the written procedure detail the HP Emergency Response Program.

Emergency Response. In many situations HP personnel are the first to respond to a radiological emergency. The ability to assess and evaluate the situation and take immediate steps to minimize the effects of the event is crucial for controlling the emergency. The HP personnel must use their training and experience to make good decisions during the initial response to an emergency.

An emergency response may be initiated by personnel observing the event, alarms, the Patrol Operation Center, or the Emergency Control Center(s) once they are manned. For a planned response, HP personnel shall be in teams of at least two. Out of necessity (e.g., backshift response), one member could be an Operations person or other emergency service person such as fire or patrol. A rapid response is required; however, no undue risks should be taken nor

should employee personnel safety be compromised. The type of emergency determines the level of planning for HP response. For example, a continuous air monitor (CAM) alarm or a small radioactive spill requires little planning for the initial response. However, when an emergency causes a facility evacuation, preplanning (e.g., stay time, entry route) by and approval of the Building/Facility Emergency Director are necessary for re-entry.

Although HP personnel respond to an emergency using basic guidelines, an area/facility may have specific procedures that have priority over these guidelines.

WHC-IP-0692, Section 12.1.2.3, "Effluent Exhaust CAM Alarm Response." This procedure establishes the standard method of handling samples from, and response to alarms at, Effluent Exhaust CAM systems. This procedure describes the steps and material necessary to exchange, perform field concentration calculations, and submit suspect samples for "rush" or "Red Envelope" analysis when responding to alarms on Effluent Exhaust CAM systems.

WHC-IP-0692, Section 12.1.6, "Stack Effluent Release Response." This procedure establishes guidelines for responding to a potential or actual release of radioactive material through exhaust stacks. This procedure describes the immediate actions to respond to an exhaust (CAM) stack alarm (i.e., CAM monitoring downstream or upstream of the final filtration).

WHC-IP-0692, Section 12.2.1, "Emergency Response Air Sampling." This procedure establishes the instruction and guidelines for air sampling in an emergency situation. This procedure describes the steps for air sampling both inside and outside facilities when a release of radioactive material is suspected.

WHC-IP-0692, Section 12.2.3, "Health Physics Emergency Response Team." This procedure provides the organizational structure of, the instructions for, and the responsibilities of the HP Emergency Response Team and the Radiation Protection Technologist (RPT) Field Survey Teams. This procedure describes the steps for an initial emergency response by the HP Emergency Response Team (ERT) and RPT Field Survey Teams. The HP ERT and the RPT Field Survey Teams may be requested to respond to an emergency when it is deemed that an environmental release of radioactive material may extend beyond the control of a facility or outside the boundaries of the Hanford Site. These teams will have monitoring responsibilities only outside the boundaries of the event site.

WHC-IP-0692, Section 12.2.4, "Emergency Radioactive Plume Tracking." This procedure establishes the instructions to track a plume created from a radioactive material release to the environment. This procedure describes the steps to track and to determine if a radioactive beta-gamma plume is at ground level or at an elevated level.

Notifications and reporting of specific events related to environmental releases and/or events involving effluents and/or

hazardous materials are reported via instruction given in WHC-CM-5-34 (WHC 1991c), *Solid/Liquid Waste Remediation Operations Administration*, Section 1.18, "Occurrence Reporting and Processing of Operations Information." The purpose of this procedure is to establish and implement specific criteria and requirements for the identification, categorization, notification, and reporting of occurrences within the Solid/Liquid Waste Division, including the 340 Facility, as required by WHC-CM-1-3 (WHC 1990b), MRP 5.14, "Occurrence Reporting and Processing of Operational Information."

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

Drawing H-3-34406 (DOE-RL 1978), "HVAC Elevations, Sections and Details," shows stack dimensions and sampling site location. As shown, the stack is 18 in. in diameter. The sample site is located 10 ft downstream (or 6.6 duct diameters) from the last disturbance and 2 ft (or 1.3 duct diameter) from the point of release. This location meets the criteria specified in 40 CFR 60, Appendix A, Method 1A (EPA 1991).

The sample probe was designed and installed by Air Monitor Corporation (AMC). The Certified Vendor Information, CVI-30256, Operating and Maintenance Manual for the 300 Area Radioactive Liquid Waste System (Air Monitor Corporation), contains the probe design drawings and a detailed explanation of how American National Standards Institute (ANSI) standards are applied. To summarize here, the stack has one sample probe with eight sample nozzles. The AMC sampling unit uses an air profiling station to produce a flat velocity profile of non-rotating, straight air. This allows for isokinetic sampling and measuring the stack velocity and volume under almost any condition of airflow.

4.3.2 A description of sampling probes and representativeness of the samples

The sample probe was designed and installed by AMC. The CVI-30256 contains the probe design drawings and a detailed explanation of how ANSI standards are applied. To summarize here, the stack has one sample probe. It has 20 total pressure sensors, 4 static pressure sensors, and 8 sample nozzles. The inside diameter of each nozzle is 0.58 in. and each covers 0.224 ft^2 of area. The AMC sampling unit uses an air profiling station to produce a flat velocity profile of non-rotating, straight air. This allows for isokinetic sampling and measuring the stack velocity and volume under almost any condition of airflow.

4.3.3 A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

Not applicable; emissions are not monitored continuously for compliance purposes.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

The sampler runs continuously to ensure a representative sample. Radioactive particulates are captured on a high-efficiency particulate air filter as described in Section 2.1 of this document. Radioactive iodine is captured on a charcoal cartridge as described in Section 2.2.2 of this document. Samples are collected weekly, in accordance with procedures WHC-IP-0692, *Health Physics Procedures Manual*, Section 5.2.3.1, "Air Sample Exchange" (WHC 1991a), and Health Physics Scheduled Radiation Survey Task Description for Building 340, Task No. J-W005, (WHC 1993). There are no calibrations required for the particulate filter or the charcoal cartridge.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured, including frequency of analysis calibration procedures and frequency of calibration.

Laboratory analysis procedures used for Stack 340-NT-EX record samples are described by the information in Appendix H.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

The sample flow rate is regulated using a rotameter provided by Dwyer Instruments. These rotameters are described in Certified Vendor Information CVI-30268, "Flowmeters," model number RMA-9-TMV (Dwyer Instruments). The visual float is verified weekly during sample collection in accordance with WHC-IP-0692, *Health Physics Procedures Manual*, Section 5.2.3.1, "Air Sample Exchange." Rotameters are scheduled for calibration annually. The calibration is completed in accordance with Calibration Procedure 1148, "Calibrate Rotameter" (Becken 1990).

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

The flow measurements for Stack 340-NT-EX are required annually at a minimum in accordance with the 300 Area Maintenance Engineer Services procedure #1135. A pitot tube is inserted into a test port to measure the velocity pressure, which is then converted to flow using a table and equation from the data sheet for the procedure.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

The objectives of the quality assurance program will be described in a future Environmental Protection Quality Assurance Project Plan.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

Laboratory requirements are presented in Appendix H.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

See Section 6.2.3 of the main body of this report.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

See Section 7.0 of the main body of this report.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

See Section 8.0 of the main body of this report.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

See Section 9.0 of the main body of this report.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The quality assurance program for stack 340-NT-EX will be described in a future Quality Assurance Project Plan.

REFERENCES

Air Monitor Corporation, Operating and Maintenance Manual for 300 Area Radioactive Liquid Waste System, Air Monitor Corporation, Santa Rosa, California.

Becken, G.W., 1990, Maintenance Engineering Services "Calibration Procedure," Procedure 1148, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE-RL, 1978, "HVAC Elevations Sections and Details," Drawing No. H-3-34406, U.S. Department of Energy-Richland Operations Office, Richland, Washington.

Dwyer Instruments, "Flowmeters: Rate-Master® Series and Visi-Float® Series," Bulletin F-41, Dwyer Instruments, Inc., Michigan City, Indiana.

EPA, 1991, "Standards of Performance for New Stationary Sources," Title 40, *Code of Federal Regulations*, Part 60, U.S. Environmental Protection Agency, Richland, Washington.

Gelman Sciences, Internal Memo from Karol Butcher, Gelman Sciences, to Carter Kirk, Westinghouse Hanford Company, re: Versapor 3000, DOP Efficiency, dated October 31, 1991.

WHC, 1990a, *Health Physics Practices Manual*, as amended, WHC-CM-4-12, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990b, *Management Requirements and Procedures*, as amended, WHC-CM-1-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Health Physics Procedures Manual*, WHC-IP-0692, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, Health Physics Scheduled Radiation Survey Task Description for Building 340, 300 Area, Task No. J-W005, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991c, *Solid/Liquid Waste Remediation Operations Administration*, WHC-CM-5-34, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX G

METHOD 114 COMPARISON FOR THE 222-S LABORATORY

A. K. Dasgupta

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APPENDIX G

METHOD 114 COMPARISON FOR THE 222-S LABORATORY

Emissions monitoring practices for the following Hanford Site main stacks are evaluated for compliance with the radionuclide emission requirements defined in Title 40 Code of Federal Regulations (CFR) Part 61, Subpart H, "National Emission Standards for Hazardous Air Pollutants" (NESHAP) (EPA 1991):

a. 291-A-1--Plutonium-Uranium Extraction (PUREX) Plant Main Exhaust Stack
b. 291-B-1--B Plant Main Stack
c. 291-Z-1--Plutonium Finishing Plant Main Stack
d. 296-A-22--242-A Evaporator
e. 296-A-40--241-AP Tank Exhaust, Tank Farm
f. 340-NT-EX--Waste Handling Facility.

The effluents from each of these stacks are well characterized. The characterizations of radionuclide composition in emissions are in complete agreement with the operations carried out in respective facilities generating radioactive emissions. Samples of emissions are collected from the stacks having the potential to contain the radionuclides given in Table G-1 in concentrations at the stack exits that may exceed 10% of any of the Derived Concentration Guides values provided in DOE Order 5400.5 (DOE 1990). The samples from stacks a through e above are delivered to the 222-S Laboratory and analyzed for each of the radionuclides listed in Table G-1.

The laboratory receives weekly or daily main stack air filter samples from the facilities. They are usually 47-mm filters (acrylic copolymer on nylon), except from PUREX where 5-in. (127-mm) filters are used. Before analysis is performed, samples are held for 7 days so that radon/daughters, if present in the filters, can decay away.

The emissions collection media, sodium hydroxide bubbler and silica gel, are used only at the PUREX main stack for collecting ^{14}C and ^{3}H, respectively, and are sent biweekly to the laboratory for analysis.

The radionuclides ^{131}I, ^{129}I, ^{103}Ru, ^{106}Rh, ^{113}Sn, and ^{125}Sb are monitored at the PUREX, 242-A Evaporator, and AP Tank Farm main stacks. Samples are collected using silver zeolite cartridges that are sent weekly to the laboratory for identification of radionuclides and determination of their activity.

After a 7-day decay period, the total alpha/total beta activity concentrations in the weekly and daily air particulate samples are determined (procedure LA-508-110). This screening process is performed to make a quick evaluation of activity levels in the main stack air streams. If the activity level for a specific main stack is found to be significantly increased, as

Table G-1. Radionuclides

Nuclides requested for analysis	PUREX 291-A-1	B Plant 291-B-1	Z-Plant 291-Z-1	242-A Evaport. 296-A-22	241-AP tank 296-A-40	T Plant 291-T-1
Alpha Emitter	Am-241, Pu-238, Pu-239 & Pu-240	Am-241, Pu-238, Pu-239 & Pu-240	Am-241, Pu-238, Pu-239 & Pu-240			Am-241, Pu-238, Pu-239 & Pu-240
Beta Emitter	Sr-89, Sr-90/ Y-90, Pm-147, C-14 & H-3 (gas)	Sr-89, Sr-90/ Y-90		Sr-89, Sr-90/Y-90	Sr-89, Sr-90/Y-90	
Gamma emitter[a]	Nb-95, Zr-95, Cs-134, Cs-137 & Ce-144 I-129[b] I-131[b] Rh/Ru-106[b] Ru-103[b] Sn-113[b] Sb-125[b]	Cs-134 & Cs-137		Cs-134 & Cs-137 I-129[b] I-131[b] Rh/Ru-106[b] Ru-103[b] Sn-113[b] Sb-125[b]	Cs-134 & Cs-137 I-129[b] I-131[b] Rh/Ru-106[b] Ru-103[b] Sn-113[b] Sb-125[b]	
Gross Activity	TA/TB[c]	TA/TB	TA/TB	TA/TB	TA/TB	TA/TB

[a] The gamma spectroscopic technique is used for analyses of these radionuclides because they emit gamma rays of high intensity.
[b] These radionuclides are collected on silver zeolite sampling media.
[c] Total alpha and total beta analysis.

indicated by its total alpha/total beta data, then facility personnel are contacted to alert them of a change in emissions. It is important to note here that continuous process control air monitoring systems with alarms are installed at each main stack for near real-time response to elevated releases. These alarms will allow rapid response from facility personnel if the situation warrants. For compliance, the screening of weekly total alpha/total beta measurements is made assuming the most limiting alpha particulate ($^{239,240}Pu$) and the most limiting beta-emitting radionuclide (^{90}Sr) in the Hanford Site stack effluents. To ensure conservatism, the 222-S Laboratory performs specific radionuclide analyses on a composite of all filters collected during a calendar quarter. Gamma energy analysis (GEA) is performed (LA-508-052) on the composite to determine the activities of the gamma emitters, particularly ^{95}Nb, ^{95}Zr, ^{134}Cs, ^{137}Cs, and ^{144}Ce.

After GEA is complete, the quarterly composite of air filters is ashed, dissolved/leached, then appropriately treated and mounted for analysis of individual alpha emitters (LA-549-112 [dissolution], LA-943-123 [chemical separation], LA-542-101 [electrodeposition], LA-508-051 [alpha spectrometry] for ^{241}Am, ^{238}Pu, $^{239,240}Pu$) and beta emitters (LA-549-112 [dissolution], LA-220-103 [chemical separation], LA-508-111 [total beta counting] for $^{89,90}Sr/^{90}Y$; LA-549-112 [dissolution], LA-613-111 [chemical separation], LA-548-111 [mounting in scintillation cocktail], LA-508-121 [scintillation counting] for ^{147}Pm), depending on the type of analyses requested by the facility and 200 Areas Environmental Protection group.

Biweekly gas samples from the PUREX main stack, collected in sodium hydroxide bubblers and silica gel are analyzed for ^{14}C (LA-348-101 [chemical separation], LA-548-111 [mounting in cocktail], LA-508-121 [scintillation counting]) and for ^{3}H (LA-218-112 [processing], LA-548-111 [mounting in cocktail], LA-508-121 [liquid scintillation counting]), respectively. The weekly samples for ^{129}I, ^{131}I, ^{125}Sb, ^{113}Sn, ^{106}Rh, and ^{103}Ru from each of the PUREX, 242-A Evaporator, and AP Tank Farm main stacks, collected on silver zeolite cartridges, are analyzed by the GEA (LA-288-101 in conjunction with LA-508-052).

A point-by-point comparison of analyses performed with the regulatory requirements of 40 CFR 61, Subpart H, Method 114 (particularly Sections 3 and 4 as applicable to 222-S Laboratory operations) (EPA 1991) is provided in the attachment.

METHOD 114-TEST METHODS FOR MEASURING
RADIONUCLIDE EMISSIONS FROM STATIONARY SOURCES

1.0 Purpose and Background

This method provides the requirements for: (1) Stack monitoring and sample collection methods appropriate for radionuclides; (2) radiochemical methods which are used in determining the amounts of radionuclides collected by the stack sampling and; (3) quality assurance methods which are conducted in conjunction with these measurements. These methods are appropriate for emissions for stationary sources. A list of references is provided.

Many different types of facilities release radionuclides into air. These radionuclides differ in the chemical and physical forms, half-lives and type of radiation emitted. The appropriate combination of sample extraction, collection and analysis for an individual radionuclide is dependent upon many interrelated factors including the mixture of other radionuclides present. Because of this wide range of conditions, no single method for monitoring or sample collection and analysis of a radionuclide is applicable to all types of facilities. Therefore, a series of methods based on "principles of measurement" are described for monitoring and sample collection and analysis which are applicable to the measurement of radionuclides found in effluent streams at stationary sources. This approach provides the user with the flexibility to choose the most appropriate combination of monitoring and sample collection and analysis methods which are applicable to the effluent stream to be measured.

Response: **Our answers to U.S. Environmental Protection Agency (EPA) requirements (regulatory criteria 40 CFR 61, Subpart H, Appendix B, Method 114) (EPA 1991) regarding Hanford site air emissions are provided here.**

2.0 Stack Monitoring and Sample Collection Methods

Monitoring and sample collection methods are described based on "principles of monitoring and sample collection" which are applicable to the measurement of radionuclides from effluent streams at stationary sources. Radionuclides of most elements will be in the particulate form in these effluent streams and can be readily collected using a suitable filter media. Radionuclides of hydrogen, oxygen, carbon, nitrogen, the noble gases and in some circumstances iodine will be in the gaseous form. Radionuclides of these elements will require either the use of an in-line or off-line monitor to directly measure the radionuclides, or suitable sorbers, condensers or bubblers to collect the radionuclides.

Response: **No answer is required of radioanalytical chemistry.**

2.1 Radionuclides as Particulates. The extracted effluent stream is passed through a filter media to remove the particulates. The filter must have a high efficiency for removal of sub-micron particles. The guidance in ANSI N13.1-1969 shall be followed in using filter media to collect particulates (incorporated by reference-see § 61.18).

See Appendices A, B, C, D, and E.

2.2 Radionuclides as Gases.

2.2.1 The Radionuclide Tritium (H-3). Tritium in the form of water vapor is collected from the extracted effluent sample by sorption, condensation or dissolution techniques. Appropriate collectors may include silica gel, molecular sieves, and ethylene glycol or water bubblers.

Tritium in the gaseous form may be measured directly in the sample stream using Method B-1, collected as a gas sample or may be oxidized using a metal catalyst to tritiated water and collected as described above.

2.2.2 Radionuclides of iodine. Iodine is collected from an extracted sample by sorption or dissolution techniques. Appropriate collectors may include charcoal, impregnated charcoal, metal zeolite and caustic solutions.

2.2.3 Radionuclides of Argon, Krypton and Xenon. Radionuclides of these elements are either measured directly by an in-line or off-line monitor, or are collected from the extracted sample by low temperature sorption techniques, Appropriate sorbers may include charcoal or metal zeolite.

2.2.4 Radionuclides of Oxygen, Carbon, Nitrogen and Radon. Radionuclides of these elements are measured directly using an in-line or off-line monitor. Radionuclides of carbon in the form of carbon dioxide may be collected by dissolution in caustic solutions.

See Appendices A, D, and E.

2.3 Definition of Terms

In-line monitor means a continuous measurement system in which the detector is placed directly in or adjacent to the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2, and G-4.

Off-line monitor means a measurement system in which the detector is used to continuously measure an extracted sample of the effluent stream. This may involve either gross radioactivity measurements or specific radionuclide measurements. Gross measurements shall be made in conformance with the conditions specified in Methods A-4, B-2 and G-4.

Sample collection means a procedure in which the radionuclides are removed from an extracted sample of the effluent using a collection media. These collection media include filters, absorbers, bubblers and condensers. The collected sample is analyzed using the methods described in Section 3.0.

Response: No answer is required.

3.0 Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are described which are applicable to the analysis of radionuclides collected from airborne effluent streams at stationary sources. These methods are applicable only under the conditions stated and within the limitations described. Some methods specify that only a single radionuclide be present in the sample or the chemically separated sample. This condition should be interpreted to mean that no other radionuclides are present in quantities which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining the activity of any alpha-emitting radionuclide, regardless of what other radionuclides are present in the sample provided the chemical separation step produces a very thin sample and removes all other radionuclides which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

Response: Our method involves dissolution (LA-549-112), chemical separation (LA-943-123), electrodeposition (LA-542-101), followed by alpha spectrometry (LA-508-051). It meets all the requirements of the EPA-suggested method. This is used for analyzing ^{241}Am, ^{238}Pu, and $^{239,240}Pu$ in the air filter samples. The activities of these nuclides are determined by direct comparison with the recoveries of (National Institute of Standards and Technology ([NIST] traceable) ^{243}Am and ^{236}Pu tracers.

3.1.2 Method A-2, Radiochemistry-Alpha Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on

a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It may also be applicable for determining compliance, when other radionuclides of the separated element are present, provided that the calculated emission rate is assigned to the radionuclide which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

Response: Because the tracer technique is used in the separation process, this method is not used for air filter analysis.

3.1.3 Method A-3, Direct Alpha Spectrometry.

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM) or better, ASTM-D-3084(16).

Response: Our method follows the procedure LO-150-133, then LA-508-110 for total alpha counts, and finally LA-508-051 for alpha spectrometry. It partially meets the requirements of the EPA method. This method is usually used for emergency air samples. The sample is counted on the alpha counter of known efficiency to obtain the total alpha counts. In the alpha energy analysis (AEA), the relative peak fractions of different alpha emitters identified in the sample are determined. The peak fractions are then used to correct the total alpha counts and thus determine the activities of individual alpha nuclides present in the sample.

3.1.4 Method A-4, Direct Alpha Counting (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determination may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, or the identity and isotopic ratio of the radionuclides in the sample are well known, and (2) measurements using either Method A-1, A-2 or A-5 have shown that this method provides a reasonably accurate measurement of the emission rate. Gross alpha measurements are applicable to unidentified mixtures of radionuclides only for the purposes and under the conditions described in Section 3.7. APHA-601(3), ASTM-D-1943(10).

Response: The filter samples are counted in a low background thin-window gas-flow proportional counter with a guard detector operated in coincidence mode. It uses pulse height discriminator to separate alpha & beta activity. Our method follows the procedure LA-508-110 or LA-508-114. It meets all of the requirements stated in the EPA-suggested method.

3.1.5 Method A-5, Chemical Determination of Uranium.

Uranium: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E318(15), ASTM-D-2907(14).

Response: Total uranium is determined by procedure LA-925-107. The laser-induced kinetic phosphorescence analyzer is an improvement over the old fluorometric method for uranium determination. It is highly sensitive (lower detection level of 50 ppt is quite possible) because the laser frequency is used specifically for excitation of uranium atoms. It is faster and produces quality numbers. Quality can also be monitored during analysis. It exceeds the requirements mentioned in the EPA method.

3.1.6 Method A-6, Radon-222-Continuous Gas Monitor.

Principle: Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

Applicability: This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

Response: Not applicable at the 222-S Laboratory.

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

Principle: Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is corrected to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

Applicability: Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon 220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

Response: Not applicable; direct monitoring of ^{222}Rn is not performed at the 222-S Laboratory.

3.2 Methods for Gaseous Beta Emitting Radionuclides.

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for measuring the activity of a gaseous beta emitting radionuclide in an effluent stream that is suitable as a counting gas, when no other beta-emitting nuclides are present. DOE/EP-0096(17), NCRP-58(23).

Response: Not applicable; not performed.

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

Principle: The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

Applicability: This method is applicable only to radionuclides with maximum beta particle energies greater then 0.2 MeV. This method may be used to measure emissions of specific radionuclides only when it is known that the sample contains only a single radionuclide or the identity and isotopic ratio of the

radionuclides in the effluent stream are well known. Specific radionuclide analysis of periodic grab samples may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in Section 3.7.

Response: Not applicable; not performed.

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides.

3.3.1 Method B-3, Radiochemistry-Beta Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for measuring the activity of any beta-emitting radionuclide, with a maximum energy greater than 0.2 MeV, provided no other radionuclide is present in the separated sample. APHA-608(5).

Response: Our method for determining ^{89}Sr, $^{90}Sr/^{90}Y$ in air filter samples is carried out using procedures LA-549-112 (dissolution of the filter sample by nitric acid) and LA-220-103 (for chemical separation), followed by procedure LA-508-111 (total beta counting). The laboratory method certainly meets the requirements stated above.

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: Gross beta measurements are applicable only to radionuclides with maximum beta particle energies greater than 0.2 MeV. Gross beta measurements may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, and (2) measurements made using Method B-3 show reasonable agreement with the gross beta measurement. Gross beta measurements are applicable to mixtures of radionuclides only for the purposes and under the conditions described in Section 3.7. APHA-602(4), ASTM-D-1890(11).

Response: The filter samples are counted in a low background thin-window gas-flow proportional counter with a guard detector in coincidence mode. It uses pulse height discriminator to separate alpha & beta activity.For gross beta determination, procedure LA-508-110 or LA-508-114 is followed. It satisfies the method requirements.

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to any beta-emitting nuclide when no other radionuclide is present in the sample or the separated sample provided that it can be incorporated in the scintillation cocktail. This method is also applicable for samples which contain more than one radionuclide but only when the energies of the beta particles are sufficiently separated so that they can be resolved by the spectrometer. This method is most applicable to the measurement of low-energy beta emitters such as tritium and carbon-14. APHA.609(6), EML LV-539-17(19).

Response: It is used for determining ^{147}Pm in air filter samples (LA-549-112 for dissolution of the filter by nitric acid, LA-613-111 for chemical separation to isolate the desired beta nuclide, LA-548-111 for

incorporating into scintillation cocktail, and LA-508-121 for liquid scintillation counting). This is also used for determination of ^{14}C (LA-348-101, LA-548-111, and LA-508-121, sequentially) and ^{3}H (LA-218-112, LA-548-111, and LA-508-121, sequentially) in gas samples. This method satisfies all of the requirements.

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1. High Resolution Gamma Spectrometry.

Principle: The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It can be applied to complex mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gases. The method may also be applied to the analysis of gaseous gamma emitting radionuclides directly in an effluent stream by passing the stream through a chamber or cell containing the detector. ASTM-3649(9), IDO-12096(18).

Response: The daily & weekly air filters are quarterly composited and then directly counted on a high resolution Ge detector. The silver zeolite cartridges are counted on a n-type high purity Ge detector (very useful for low gamma & x-rays). The procedure used for analysis with gamma-ray spectroscopy is LA-508-052. Our method uses gamma ray spectroscopy with high resolution germanium detectors and follows procedure LA-508-052. It meets all the requirements explained in the EPA method.

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 keV. It can be applied only to relatively simple mixtures of gamma emitting radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

Response: Not applicable because this method is not used in air filter analysis.

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It is not applicable to mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector.

Response: Not applicable because this technique is not used in air filter analysis.

3.4.4 Method G-4, Gross Gamma Counting.

Principle: The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

Applicability: Gross gamma measurements may be used to measure emissions of specific radionuclides only when it is known that the sample contains a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This method may be applied to analysis of gaseous radionuclides directly in an effluent stream by placing the detector directly in or adjacent to the effluent stream or passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

Response: Not applicable.

3.5 Counting Methods. All of the methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

▪Gas Flow Proportional Counters. The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

▪Scintillation Counters. The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

▪Solid-State Counters. Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

▪Alpha Spectrometers. Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

Response: Alpha proportional counters (home-built chambers with EG&G ORTEC electronics), thin-window-type gas flow proportional counters (some having automatic sample changer), surface-barrier solid-state detectors connected to a multichannel analyzer (MCA) (Series 85, Jupiter system manufactured by Canberra Industries, Inc.) are used for air filter analysis in 222-S laboratory. Laboratory equipment meets the EPA specifications.

3.5.2 Beta Counting:

▪Ionization Chambers. These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

▪Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters. The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

▪Scintillation Counters. The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

▪Liquid Scintillation Spectrometers. Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

Response: Thin-Window-type gas flow proportional counter (some having an automatic sample changer) liquid scintillation spectrometers manufactured by Beckman Instruments, Inc., are used for analysis. Our counting equipment meets the requirements.

3.5.3 Gamma Counting:

•Low-Resolution Gamma Spectrometers. The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

•High-Resolution gamma Spectrometers. Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

•Single Channel Analyzers. Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

Response: High-resolution gamma detectors (closed-end HPGe coaxial) and well-type pure Ge detectors (from ORTEC and Princeton Gamma Tech) connected to MCA (Canberra's Jupiter system) are available and used for air filter analysis. Our equipment exceeds the EPA requirements.

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

Response: A mixed gamma standard (NIST traceable) emitting various gamma-rays ranging from 59 to 1850 keV is used, using vendor-supplied calibration software, for constructing efficiency versus energy calibration curves for different geometrical configurations used in gamma analysis. The calibration procedure for gamma ray spectrometer is documented in LQ-508-003. Our calibration procedure meets the EPA criteria for gamma ray spectroscopic analysis.

For calibration of beta detectors for $^{90}Sr/^{90}Y$ analysis, procedure LQ-508-002 is used in conjunction with LQ-508-005. It meets the requirements of the EPA-suggested method. A method standard also is used to check the performance and calibration of the detector.

For calibration of alpha/beta proportional counters, the procedure LQ-508-002 is carried out. It partially deviates from the EPA requirements. For gross alpha and gross beta measurements, our instruments are calibrated with NIST traceable alpha emitting ^{241}Am and beta emitting ^{60}Co standards respectively, fabricated into the filter sample counting geometry. The reasons for choosing the ^{241}Am standard for alpha calibration are as follows:

- It is commonly found in the main stack air samples.

- Alpha counting efficiency usually is the same for other alpha emitters that also are found in the air stack samples
- The ^{241}Am standard also can be checked independently by gamma analysis.

The reason for using the ^{60}Co standard for beta calibration is the lower counting efficiency with ^{60}Co (beta max = 317 keV) compared to those with ^{137}Cs (beta max = 511 keV) and ^{90}Sr (beta max = 546 keV). Consequently, it will generate conservative numbers in our analysis.

The calibration curves relating weight of solids present to counting efficiencies are not done in alpha/beta analysis, but currently are being evaluated.

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which hove the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1, methods based on any of the applicable "principles of measurement" described in Section 3.1 through 3.4 may be used.

Response: The air samples from the main stacks are well characterized. Some of the radionuclides identified (^{241}Am, ^{238}Pu, $^{239,240}Pu$, ^{90}Sr, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{14}C, ^{3}H, and ^{131}I) are listed in Table 1 of Method 114 (EPA 1991) and are analyzed according to the approved methods given in the table. Other radionuclides (^{95}Nb, ^{95}Zr, ^{129}I, $^{106}Rh/^{106}Ru$, ^{113}Sn, ^{125}Sb, and ^{103}Ru) not listed in the table are analyzed by the methods outlined in Method 114, depending on the type of emitted radiations. It is important to note here that the nuclides ^{95}Zr, ^{95}Nb, and ^{103}Ru have nearly decayed to nondetectable levels because no product is being produced.

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

Response: This is not applicable because the air effluents from the Hanford Site main stacks are well characterized. However, gross alpha and beta analyses for weekly and daily air samples are routinely performed in the 222-S Laboratory before starting specific radionuclide analyses. Following this practice, the facility can verify a significant release of a radionuclide into the air so corrective actions to minimize radionuclide emission into the environment can be taken promptly by facility personnel. The gross alpha and beta results from analysis are compared to those listed in the appendix of DOE Order 5400.5 (DOE 1990) for compliance.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written

procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.1 The organizational structure functional responsibilities, levels of authority and lines of communications for all activities related to the emissions measurement program shall be identified and documented.

The company manual WHC-CM-1-2, *Organizational Charts and Charters*, exhibits the current company organizational structure and titles. This manual includes the organization's upper level management charters. Responsibilities for radioactive airborne emissions sampling activities are described in the main pat of this document.

4.2 Administrative controls shall be prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.

See Appendices A, B, C, D, and E.

4.3 The sample collection and analysis procedures used in measuring the emissions shall be described including where applicable:

4.3.1 Identification of sampling sites and number of sampling points, including the rationale for site selections.

See Appendices A, B, C, D, and E.

4.3.2 A description of sampling probes and representativeness of the samples.

See Appendices A, B, C, D, and E.

4.3.3 A description of any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures and frequency of calibration.

See Appendices A, B, C, D, and E.

4.3.4 A description of the sample collection systems for each radionuclide measured, including frequency of collection, calibration procedures and frequency of calibration.

See Appendices A, B, C, D, and E.

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured. including frequency of analysis calibration procedures and frequency of calibration.

Response:

- Total alpha/total beta activity is determined by procedure LA-508-110 or LA-508-114 on weekly samples, and occasionally on daily air samples, per collection point. The calibration procedure is documented in LQ-508-002. It is done only when deemed necessary by a responsible scientist. The counting system is recalibrated only in case of (1) major repairs or adjustments to the power supply or detector or (2) calibration shift as indicated by the instrument control standards. The performance of the counting systems is checked by running the instrument control standards (^{147}Pm for low-energy beta, ^{60}Co for mid-energy beta, ^{137}Cs for high-energy beta, and ^{241}Am for alpha activity) separately. When a batch of air filter samples is run, all the performance standards and the background (for counting frequency refer to LO-150-115) also are run with it. To verify that the counting system is working properly, the standard values from analysis should fall within the

administrative limits set according to appropriate quality assurance program plans (QAPP).

- Our laboratory method for analysis of alpha emitters (^{241}Am, ^{238}Pu, and $^{239,240}Pu$) involves various steps (LA-549-112 for dissolution, LA-943-123 for chemical separation, LA-542-101 for electrodeposition, and LA-508-051 for final alpha spectrometry). The analysis of alpha emitters is done quarterly on weekly/daily air filter samples. The energy resolution and calibration of the AEA system over the energy range of 4 to 6 MeV are checked once a month by the preventive maintenance (PM) procedure 2S18006. Efficiency calibration of the AEA is not needed in our analysis method because direct comparison of the sample with recoveries of the tracers (^{243}Am and ^{236}Pu) is made to determine the activities of the radionuclides present in the sample. To carry out the sample analysis, AEA system performance is checked once every 24 hours for alpha energy shift with a certified mixed alpha source standard. Each alpha energy peak identified in the standard must fall within administratively assigned certain channels ($\pm$10) on the MCA. For counting frequency of performance check standards, procedure LO-150-115 is referred to. The recovery of the radionuclides and the calibration of the system are checked on a batch basis by running a method standard under the identical conditions as the sample.

- The lab method for determining beta activity (^{89}Sr, $^{90}Sr/^{90}Y$) consists of a dissolution step (LA-549-112), chemical separation (LA-220-103), and total beta counting (LA-508-111). Analysis is done quarterly on weekly/daily air filter samples per collection point. The calibration procedure LQ-508-002 (for window-type gas flow proportional counter) is used in conjunction with LQ-508-005 (for mother/daughter case, i.e., $^{90}Sr/^{90}Y$ in growth calibration). It is performed only when the responsible scientist finds it necessary. The reasons are the same as stated for total alpha/total beta. The performance of the counting system is checked once per shift by running instrument control standards (^{60}Co, ^{137}Cs, and ^{147}Pm for beta activity). The complete procedure for the $^{90}Sr/^{90}Y$ analysis in the sample is carried out with a method standard (several filter papers spiked with ^{90}Sr, ^{147}Pm, ^{60}Co, ^{241}Am, ^{239}Pu, and U) provided by the 222-SA Standard Laboratory) on a batch basis. This checks the overall performance of our method. The chemical yield is determined by using appropriate carrier.

- Determination of beta activity (^{147}Pm, ^{14}C, and ^{3}H) involves processing (LA-549-112 and LA-613-111 for ^{147}Pm, LA-348-101 for ^{14}C, and LA-218-112 for ^{3}H), mounting in scintillation cocktail (LA-508-111), and finally, liquid scintillation counting (LA-508-121). The ^{147}Pm analysis is done on quarterly composites of weekly/daily air filter samples. The ^{14}C and ^{3}H analyses are done on biweekly gas samples. For calibration, the quality assurance (QA) section of procedure LA-508-121 is referenced. The calibration of the instrument is checked by the manufacturer's supplied sources (^{14}C and ^{3}H) and its software.

For ^{147}Pm analysis, the method standard is run once per quarter. The method standard is always run with a batch of samples for ^{3}H and ^{14}C analysis. The results of the method standard checks the overall performance, including the calibration of the counting system. The instrument calibration check is done a minimum of once a week (refer to LO-150-115).

- For analysis of gamma emitters ^{95}Nb, ^{95}Zr, ^{134}Cs, ^{137}Cs, and ^{144}Ce the procedure LA-508-052 is followed. Analysis is done on quarterly composites of weekly/daily air filter samples. For analysis of volatile radionuclides (^{129}I, ^{131}I, $^{106}Rh/^{106}Ru$, ^{113}Sn, ^{125}Sb, and ^{103}Ru) collected weekly on silver zeolite cartridge, the procedure LA-288-101 is used in conjunction with procedure LA-508-052. Calibration of the gamma ray spectrometer is done with the procedure documented in LQ-508-003 using a (NIST traceable) certified mixed gamma ray standard. It is carried out only when it is deemed necessary by a responsible scientist. To check efficiency and energy calibration daily, the performance of each detector of the GEA system over the whole energy range is done once every shift by running a mixed gamma standard consisting of ^{241}Am for low energy, ^{137}Cs for mid energy, and ^{60}Co for high energy. The results of each of these radionuclides should fall within the administrative limits set according to the appropriate QAPP to continue analysis of samples. The daily performance results are documented. Minor adjustments of the electronics (i.e., fine gain, pole zero of the amplifiers, lower level discriminator of analog-to-digital converter, etc.) are done from time to time when necessary for proper energy calibration. Whenever a minor electronic adjustment is done on a detector, it is followed by analysis of a performance standard. For a major shift in the calibration, the system is then thoroughly calibrated using LQ-508-003.

- The content of the 222-S Laboratory's procedures, test plans, supporting documents, and drawings provide a sufficient level of detail to allow trained personnel to produce quality results safely. Laboratory procedures are controlled as required by WHC-CM-5-4, Section 5.4, "Analytical Laboratory Procedures." The specific content of laboratory procedures is defined by its author, based on accepted methods such as 40 CFR 61, Appendix B, Method 114 (EPA 1991). The content must be agreed to by the peer and technical reviewers. While authors are responsible for the specific content of their procedures, they address the topics below.

  Summary - MANDATORY - A short description or abstract of the procedure containing enough information to distinguish it from other procedures.

  Applications - MANDATORY - Defines the scope and purpose of the specific procedure. This section may be combined with the following element under the title "Applications and Limitations."

  Limitations - MANDATORY - Briefly describes those areas in which the procedure is not applicable. A statement of accuracy and precision will be given where appropriate.

Quality Control Protocol - Procedures used to support environmental projects that have specific quality control requirements. For these procedures, the source of the quality control requirements will be identified. The samples or project that this element applies to will be identified. The following information is typical of quality control requirements: frequency and type of calibration, reagent blank analysis, spike sample analysis, and duplicate sample analysis.

Impact Level Identifier - MANDATORY - An impact level will be identified for each procedure following WHC-CM-1-3, MRP 5.43, with a brief basis of determination statement. This MRP lists several descriptive paragraphs delineating what constitutes an Impact Level 1, 2, 3, or 4 activity. The following parts of MRP 5.43 cover most analytical laboratory procedures.

1. Section 5, paragraph 6, part c., Impact Level 3 - work authorization documentation associated with work involving occupational hazards not covered by approved procedure, such as Operational Safety Assessments, Radiation Work Permits, or Industrial Safety Standards.

2. Section 5, paragraph 6, part c., Impact Level 4 - Documentation for any activity not classed as Impact Level 1, 2, or 3.

The laboratories' procedures are usually specific to one activity. These activities are well defined using common scientific instrumentation and equipment operated in an acceptable manner. The chemicals and materials used are normally small quantities with limited potential for environmental or personnel safety impact. In general, the equipment used in the laboratory is not classified as Safety Class 3 or higher.

Safety - MANDATORY - The procedure must identify applicable safety hazards.

The following documents identify Westinghouse Hanford Company (Westinghouse Hanford) safety requirements:

- WHC-CM-4-3, Volume 1-3, Industrial Safety
- WHC-CM-4-10, Radiation Protection
- WHC-CM-4-15, Radiation Work Requirements and Work Permits Manual
- WHC-CM-4-29, Nuclear Criticality Safety.

Supporting document WHC-SD-CP-LB-003, *Safety in the Analytical Laboratory*, is the laboratory general safety document. The authors must review safety requirements and include safety warnings appropriate to the actions directed by the procedure.

Reagents - If the procedure requires analytical reagents, a list of reagents will be provided. The MSDS number will be placed in brackets by each chemical name. Reagent makeup, storage container requirements, unique storage needs, shelf-life requirements, special labeling, and special preparation steps will be included. Special notations for any known or suspected carcinogen as listed on WHC-CM-4-3, Volume 2, Table 1, "WHC Master Carcinogen List," will be made on the reagent list.

Reagent preparation described fully in other current Westinghouse Hanford documentation may be included by reference.

Equipment - Special equipment needs will be listed. Standard hood or glovebox equipment is assumed to be available at the work station and does not need to be listed. The fabrication of off-standard equipment will be referenced or described in this section.

Procedure Steps - MANDATORY - A step-by-step description of operations necessary to perform the task will be presented in a logical and sequentially numbered order or an assignment of responsibilities. CAUTIONS and WARNINGS notations will be included for the applicable safety hazard before the action is described. Steps with potential for criticality specification violation will be identified. Explanatory "Notes" may be included for clarification of process.

Calculations - Calculations required to complete the work will be described in this section. Examples with sample values may be included. All combined factors will be fully described and units noted.

Calibrations - When calibrations are required, a description of how to carry out required calibrations will be given.

Discussion - A discussion of the theoretical aspects of the procedure. Brief identification of unique characteristics and interfaces to aid in troubleshooting may be included.

References - A reference list of published information to provide technical basis for the procedure may be included.

The mandatory topics are addressed in both procedures. However, the laboratories have technical, analytical, and administrative procedures. Non-mandatory topics are included if appropriate to the activity covered by the procedure.

The calibrations of all laboratory instruments are controlled by the Laboratory Instrument Calibration Control System (LICCS) (WHC-CM-5-4, Section 8.2). The LICCS documents the requirements for and the performance of calibration activities for each analytical instrument or measurement device.

4.3.6 A description of the sample flow rate measurement systems or procedures, including calibration procedures and frequency of calibration.

See Appendices A, B, C, D, and E.

4.3.7 A description of the effluent flow rate measurement procedures, including frequency of measurements, calibration procedures and frequency of calibration.

See Appendices A, B, C, D, and E.

4.4 The objectives of the quality assurance program shall be documented and shall state the required precision, accuracy and completeness of the emission measurement data including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of data obtained compared to the amount expected under normal conditions.

The accuracy of analyses is checked using percent recovery. The evaluation of blind or known check standards provides the percent recovery.

For both blind and known check standards, percent recovery is calculated by the following equation:

$$P = 100 \cdot \frac{R}{S_t}$$

Where:

P = Percent recovery

R = Measured or recovered analyte concentration in the check standard

S_t = Concentration of analyte in the check standard.

The laboratories do not use manual W. A. Shewhart control charts (Shewhart 1931). The Laboratory Measurement Control System (LMCS) is a software package designed for support of management quality control decisions. Each analytical measurement system has different control parameter requirements based on the use of specific standards. The LMCS program provide a performance versus limits control chart for each standard. The average percent recovery ($\bar{P}$) or 100%, depending on the method, marks the center of the limit. The upper and lower boundaries of the limits are multiples of the standard deviation (s) of the average percent recovery. The laboratory manager approves the LMCS limits, defined as $\bar{P} \pm ns$, where n is a positive number. The values for $\bar{P}$ and s are either performance based. In general, management sets the warning limits at 2s and the control limits at 3s or their equivalent.

When the LMCS identifies an out-of-control method, it automatically initiates corrective action. The system issues an Off Standard Condition Report (OSCR). The scientist in charge of the method must discover and resolve the problem to close out the OSCR. Until the OSCR has been

clear, personnel can not perform any analyses by this method. After the scientist has resolved the problem, personnel evaluate all analyses performed since the last in-control point.

The laboratories assess precision by examining the results from split samples or laboratory duplicates. Percent relative difference measures the precision of analyses. Percent relative difference is computed by the following equation:

$$RD = 100 \cdot \frac{S_d}{\bar{X}}$$

Where:

RD - Percent relative difference

S_d - The standard deviation estimate of the duplicate data set

$\bar{X}$ - The arithmetic mean (average) of the duplicate data set.

The initial QA objective for completeness of analyses in the laboratories is 90%. This means that the goal is to produce usable analytical data for a minimum of 90% of the analyses requested on all samples submitted to the laboratory. The laboratory evaluates actual performance against the 90% objective. If the laboratory performance drops below this limit, management initiates corrective action. This action shall identify and correct those activities within the laboratory that have caused the drop in performance.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

The samples analyzed under this program consist of mounts made from preparation of stack filters. Each sample collection point produces only one sample which is sent to the laboratory for analysis. No replicate samples are available. Repeat measurement of individual samples are made at the discretion of the scientist in charge.

As a type of process control samples, stack filters are not subject to matrix effects and radionuclide spikes are not used. However, tracer elements ^{243}Am and ^{236}Pu support the analysis of ^{241}Am, ^{238}Pu, and $^{239,240}Pu$ in the quarterly composite of weekly filter samples.

The laboratory does not split samples. There is no guarantee that the distribution of material on the filter will be homogenous. Because of this, no subsampling procedure, such as splitting, can be assured of producing two representative portions. Also, splitting the sample in effect dilutes the sample, which would adversely effects the method detection limits.

Formal blanks are not available for these analysis. However, prior to the analysis of a batch of samples, the background of the counting instrument is checked. This background check as made on each planchet and planchet holder.

Control charts and standards used in support of these analysis are described in Section 4.4.

4.6 A sample tracking system shall be established to provide for positive identification of samples and data through all phases of the sample collection, analysis and reporting system. Sample handling and preservation procedures shall be established to maintain the integrity of samples during collection, storage and analysis.

These samples come from fixed sample points and are analyzed according to established sample schedules. When requesting an analysis, the customer accesses the laboratory's sample and information management system which connects to the database, where the customer enters the request for analysis following LC-608-001, "LCCS User." The system generates the next available sample identification number and transmits it to the customer. The customer's activities, except for use of the laboratory's sample and information systems, are not covered by the laboratory's QAPP.

Sample traceability begins with the database issuance of a unique sample identification number to the requesting customer. With this number the database references the date and time of the request, the customer's identification, the sample point, and type of analysis. Other information required to maintain the traceability of samples, such as date and time of sampling, is controlled by the customer and is not covered by this QAPP.

For each requested analysis, the database generates an analytical card. The card lists the sample, customer, and analysis requested. When the sample arrives at the laboratory, it is matched to its analytical card. The sample is then carried through the analysis listed on the card. Due to the turnaround time required on these samples, they are not normally stored. If it should become necessary, the 222-S Laboratory has secure laboratory storage available.

4.7 Periodic internal and external audits shall be performed to monitor compliance with the quality assurance program. These audits shall be performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.

Personnel within the laboratory and data quality perform internal audits on laboratory analytical activities. These internal audits do not supplant the activities of the organizations directed by policy to perform company-wide audits and surveillances, nor does the laboratory QAPP cover them.

4.8 A corrective action program shall be established including criteria for when corrective action is needed, what corrective action will be taken and who is responsible for taking the corrective action.

The laboratories follow the corrective action system defined in WHC-CM-1-3, MRP 5.1, "Corrective Action Management System." In addition, for analytical work the laboratories have an internal quality control system based on the analyses of chemical standards that can initiate a corrective action request.

4.9 Periodic reports to responsible management shall be prepared on the performance of the emissions measurements program. These reports should include assessment of the quality of the data, results of audits and description of corrective actions.

See Section 9.0 of the main body of this report.

4.10 The quality assurance program should be documented in a quality assurance project plan which should address each of the above requirements.

The future Environmental Protection Project Plan and Laboratory Quality Assurance Program Plan will address quality assurance for radioactive airborne emissions sampling and reporting.

REFERENCES

DOE, 1990, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, U.S. Department of Energy, Washington, D.C.

EPA, 1991, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, U.S. Environmental Protection Agency, Washington, D.C.

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LA-548-111
LA-549-112
LA-613-111
LA-925-107
LA-943-123
LO-150-115
LQ-508-002
LQ-508-003
LQ-508-005
PM# 2SI8006
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APPENDIX H

METHOD 114 COMPARISON FOR 325 LABORATORY

M. R. Weiler
Pacific Northwest Laboratory

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APPENDIX H

METHOD 114 COMPARISON FOR 325 LABORATORY

3.0 Radionuclide Analysis Methods

A series of methods based on "principles of measurement" are described which are applicable to the analysis of radionuclides collected from airborne effluent streams at stationary sources. These methods are applicable only under the conditions stated and within the limitations described. Some methods specify that only a single radionuclide be present in the sample or the chemically separated sample. This condition should be interpreted to mean that no other radionuclides are present in quantities which would interfere with the measurement.

Also identified (Table 1) are methods for a selected list of radionuclides. The listed radionuclides are those which are most commonly used and which have the greatest potential for causing dose to members of the public. Use of methods based on principles of measurement other than those described in this section must be approved in advance of use by the Administrator. For radionuclides not listed in Table 1, any of the described methods may be used provided the user can demonstrate that the applicability conditions of the method have been met.

The type of method applicable to the analysis of a radionuclide is dependent upon the type of radiation emitted, i.e., alpha, beta or gamma. Therefore, the methods described below are grouped according to principles of measurements for the analysis of alpha, beta and gamma emitting radionuclides.

3.1 Methods for Alpha Emitting Radionuclides

3.1.1 Method A-1, Radiochemistry-Alpha Spectrometry.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemical techniques. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a very thin film by electrodeposition or by coprecipitation on a very small amount of carrier, such as lanthanum fluoride. The deposited element is then counted with an alpha spectrometer. The activity of the nuclide of interest is measured by the number of alpha counts in the appropriate energy region. A correction for chemical yield and counting efficiency is made using a standardized radioactive nuclide (tracer) of the same element. If a radioactive tracer is not available for the element of interest, a predetermined chemical yield factor may be used.

Applicability: This method is applicable for determining the activity of any alpha-emitting radionuclide, regardless of what other radionuclides are present in the sample provided the chemical separation step produces a very thin sample and removes all other radionuclides which could interfere in the spectral region of interest. APHA-605(2), ASTM-D-3972(13).

The sample filter is destroyed by digestion with nitric acid. Activity ratios for any alpha emitters present are determined by alpha spectral analysis of a thin-film deposit prepared by electrodeposition of an aliquot from the digestion from a dimethyl sulfoxide matrix. The alpha spectrometry system consists of alpha spectrometry modules connected to a pulse height analyzer. Activity of individual alpha-emitting nuclides is calculated using the measured alpha activity ratios and a total alpha measurement performed on an aliquot of the digestion solution.

3.1.2 Method A-2, Radiochemistry-Alpha Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix using radiochemistry. The procedure may involve precipitation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet in a thin film and counted with a alpha counter. A correction for chemical yield (if necessary) is made. The alpha count rate measures the total activity of all emitting radionuclides of the separated element.

Applicability: This method is applicable for the measurement of any alpha-emitting radionuclide, provided no other alpha emitting radionuclide is present in the separated sample. It may also be applicable for determining compliance, when other radionuclides of the separated element are present, provided that the calculated emission rate is assigned to the radionuclide which could be present in the sample that has the highest dose conversion factor. IDO-12096(18).

The technique of chemically separating and individually determining alpha emitting nuclides is employed only when filter sample dissolution produces a solution unsuitable for alpha spectrometry (Method 3.1.1). Counting systems described for Methods 3.1.1, 3.1.3, and 3.1.5 are employed in alpha counting operations relating to separated nuclides. Where isotopic measurements of a single element are required and the respective alpha energies do not permit satisfactory differentiation, mass spectrometry is employed.

3.1.3 Method A-3, Direct Alpha Spectrometry.

Principle: The sample, collected on a suitable filter, is counted directly on an alpha spectrometer. The sample must be thin enough and collected on the surface of the filter so that any absorption of alpha particle energy in the sample or the filter, which would degrade the spectrum, is minimal.

Applicability: This method is applicable to simple mixtures of alpha emitting radionuclides and only when the amount of particulates collected on the filter paper are relatively small and the alpha spectra is adequately resolved. Resolutions should be 50 keV (FWHM) or better, ASTM-D-3084(16).

This method is not used to produce quantitative alpha data. Direct alpha spectral analysis does not provide spectra of satisfactory resolution with currently used filter media. This method may be used to identify the chemical separations, if any, required when Methods 3.1.1 and 3.1.2 are performed.

3.1.4 Method A-4, Direct Alpha Counting (Gross alpha determination).

Principle: The sample, collected on a suitable filter, is counted with an alpha counter. The sample must be thin enough so that self-absorption is not significant and the filter must be of such a nature that the particles are retained on the surface.

Applicability: Gross alpha determination may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, or the identity and isotopic ratio of the radionuclides in the sample are well known, and (2) measurements using either Method A-1, A-2 or A-5 have shown that this method provides a reasonably accurate measurement of the emission rate. Gross alpha measurements are applicable to unidentified mixtures of radionuclides only for the purposes and under the conditions described in Section 3.7. APHA-601(3), ASTM-D-1943(10).

Filter samples are counted directly in a low background counting system. The system consists of a thin-window gas-flow proportional detector and a gas-flow proportional guard detector operated in anti-coincidence, a high voltage supply, a low/wide beta amp/discriminator, a low/wide beta amp/single channel analyzer, a timer, and two scalers. The system employs pulse height discrimination to differentiate alpha and beta activity. This method is used to screen filter samples for those exhibiting alpha activity levels sufficiently above detection limits to allow application of Method 3.1.1. An alpha scintillation counter employing a zinc sulfide detector is employed to perform alpha measurements on filter samples exhibiting beta/alpha activity ratios high enough to introduce significant uncertainty into alpha results.

3.1.5 Method A-5, Chemical Determination of Uranium.

Uranium: Uranium may be measured chemically by either colorimetry or fluorometry. In both procedures, the sample is dissolved, the uranium is oxidized to the hexavalent form and extracted into a suitable solvent. Impurities are removed from the solvent layer. For colorimetry, dibenzoylmethane is added, and the uranium is measured by the absorbance in a colorimeter. For fluorometry, a portion of the solution is fused with a sodium fluoride-lithium fluoride flux and the uranium is determined by the ultraviolet activated fluorescence of the fused disk in a fluorometer.

Applicability: This method is applicable to the measurements of emission rates of uranium when the isotopic ratio of the uranium radionuclides is well known. ASTM-E318(15), ASTM-D-2907(14).

The sample filter is destroyed by digestion with nitric acid and the resulting solution is analyzed directly in aqueous solution using a pulsed laser fluorimeter.

3.1.6 Method A-6, Radon-222-Continuous Gas Monitor.

Principle: Radon-222 is measured directly in a continuously extracted sample stream by passing the air stream through a calibrated scintillation cell. Prior to the scintillation cell, the air stream is treated to remove particulates and excess moisture. The alpha particles from radon-222 and its decay products strike a zinc sulfide coating on the inside of the scintillation cell producing light pulses. The light pulses are detected by a photomultiplier tube which generates electrical pulses. These pulses are processed by the system electronics and the read out is in pCi/l of radon-222.

Applicability: This method is applicable to the measurement of radon-222 in effluent streams which do not contain significant quantities of radon-220. Users of this method should calibrate the monitor in a radon calibration chamber at least twice per year. The background of the monitor should also be checked periodically by operating the instrument in a low radon environment. EPA 520/1-89-009(24).

In-line monitoring of effluent air streams is not included in the analytical plan for the segment of the emission monitoring program performed by the Analytical Chemistry Laboratory.

3.1.7 Method A-7, Radon-222-Alpha Track Detectors

Principle: Radon-222 is measured directly in the effluent stream using alpha track detectors (ATD). The alpha particles emitted by radon-222 and its decay products strike a small plastic strip and produce submicron damage tracks. The plastic strip is placed in a caustic solution that accentuates the damage tracks which are counted using a microscope or automatic counting system. The number of tracks per unit area is corrected to the radon concentration in air using a conversion factor derived from data generated in a radon calibration facility.

Applicability: Prior approval from EPA is required for use of this method. This method is only applicable to effluent streams which do not contain significant quantities of radon-220, unless special detectors are used to discriminate against radon 220. This method may be used only when ATDs have been demonstrated to produce data comparable to data obtained with Method A-6. Such data should be submitted to EPA when requesting approval for the use of this method. EPA 520/1-89-009(24).

In-line monitoring of effluent air streams is not included in the analytical plan for the segment of the emission monitoring program performed by the Analytical Chemistry Laboratory.

3.2 Methods for Gaseous Beta Emitting Radionuclides.

3.2.1 Method B-1, Direct Counting in Flow-Through Ionization Chambers.

Principle: An ionization chamber containing a specific volume of gas which flows at a given flow rate through the chamber is used. The sample (effluent stream sample) acts as the counting gas for the chamber. The activity of the radionuclide is determined from the current measured in the ionization chamber.

Applicability: This method is applicable for measuring the activity of a gaseous beta emitting radionuclide in an effluent stream that is suitable as a counting gas, when no other beta-emitting nuclides are present. DOE/EP-0096(1 7), NCRP-58(23).

In-line monitoring of effluent air streams is not included in the analytical plan for the segment of the emission monitoring program performed by the Analytical Chemistry Laboratory.

3.2.2 Method B-2, Direct Counting With In-line or Off-line Beta Detectors.

Principle: The beta detector is placed directly in the effluent stream (in-line) or an extracted sample of the effluent stream is passed through a chamber containing a beta detector (off-line). The activities of the radionuclides present in the effluent stream are determined from the beta count rate, and a knowledge of the radionuclides present and the relationship of the gross beta count rate and the specific radionuclide concentration.

Applicability: This method is applicable only to radionuclides with maximum beta particle energies greater then 0.2 MeV. This method may be used to measure emissions of specific radionuclides only when it is known that the sample contains only a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. Specific radionuclide analysis of periodic grab samples

may be used to identify the types and quantities of radionuclides present and to establish the relationship between specific radionuclide analyses and gross beta count rates.

This method is applicable to unidentified mixtures of gaseous radionuclides only for the purposes and under the conditions described in Section 3.7.

In-line air stream samples are not included in the analytical plan for the segment of the emission monitoring program performed by the Analytical Chemistry Laboratory.

3.3 Methods for Non-Gaseous Beta Emitting Radionuclides.

3.3.1 Method B-3, Radiochemistry-Beta Counting.

Principle: The element of interest is separated from other elements, and from the sample matrix by radiochemistry. This may involve precipitation, distillation, ion exchange, or solvent extraction. Carriers (elements chemically similar to the element of interest) may be used. The element is deposited on a planchet, and counted with a beta counter. Corrections for chemical yield and decay (if necessary) are made. The beta count rate determines the total activity of all radionuclides of the separated element. This method may also involve the radiochemical separation and counting of a daughter element, after a suitable period of ingrowth, in which case it is specific for the parent nuclide.

Applicability: This method is applicable for measuring the activity of any beta-emitting radionuclide, with a maximum energy greater than 0.2 MeV, provided no other radionuclide is present in the separated sample. APHA-608(5).

The sample filter is destroyed by digestion with nitric acid. Beta-emitting nuclides are determined by one or more of the following methods:

- **Gamma spectral analysis of a digestion solution aliquot for determination of those nuclides with associated gamma activity**
- **Beta absorption measurement of a digestion solution aliquot by absorber counting in a gas-flow proportional counter**
- **Chemical separation of pure beta-emitting nuclides, followed by counting in a gas-flow proportional counter or liquid scintillation counter (Method 3.3.3).**

3.3.2 Method B-4, Direct Beta Counting (Gross beta determination).

Principle: The sample, collected on a suitable filter, is counted with a beta counter. The sample must be thin enough so that self-absorption corrections can be made.

Applicability: Gross beta measurements are applicable only to radionuclides with maximum beta particle energies greater than 0.2 MeV. Gross beta measurements may be used to measure emissions of specific radionuclides only (1) when it is known that the sample contains only a single radionuclide, and (2) measurements made using Method B-3 show reasonable agreement with the gross beta measurement. Gross beta measurements are applicable to mixtures of radionuclides only for the purposes and under the conditions described in Section 3.7. APHA-602(4), ASTM-D-1890(11).

Filter samples are counted directly in a low background counting system. The system consists of a thin-window gas-flow proportional detector and a gas-flow proportional guard detector operated in anti-coincidence, a high voltage supply, a low/wide beta amp/discriminator, a low/wide beta amp/single channel analyzer, a timer, and two scalers. The system employs pulse height discrimination to differentiate alpha and beta activity. This method is used to screen filter samples for those exhibiting beta activity levels sufficiently above detection limits to allow application of Method 3.2.3. Absorption techniques using a thin absorber are employed to perform beta measurement on filter samplers exhibiting alpha/beta activity ratios high enough to introduce significant uncertainty into beta results.

3.3.3 Method B-5, Liquid Scintillation Spectrometry.

Principle: An aliquot of a collected sample or the result of some other chemical separation or processing technique is added to a liquid scintillation "cocktail" which is viewed by photomultiplier tubes in a liquid scintillation spectrometer. The spectrometer is adjusted to establish a channel or "window" for the pulse energy appropriate to the nuclide of interest. The activity of the nuclide of interest is measured by the counting rate in the appropriate energy channel. Corrections are made for chemical yield where separations are made.

Applicability: This method is applicable to any beta-emitting nuclide when no other radionuclide is present in the sample or the separated sample provided that it can be incorporated in the scintillation cocktail. This method is also applicable for samples which contain more than one radionuclide but only when the energies of the beta particles are sufficiently separated so that they can be resolved by the spectrometer. This method is most applicable to the measurement of low-energy beta emitters such as tritium and carbon-14. APHA.609(6), EML LV-539-17(19).

The sample filter is destroyed by digestion with nitric acid. When a single beta emitter is present, only two low energy beta emitters sufficiently separated in energy for spectral resolution are present, or a chemical separation isolates a single beta-emitting nuclide, the digestion solution is analyzed in a liquid scintillation spectrometer.

3.4 Gamma Emitting Radionuclides

3.4.1 Method G-1. High Resolution Gamma Spectrometry.

Principle: The sample is counted with a high resolution gamma detector, usually either a Ge(Li) or a high purity Ge detector, connected to a multichannel analyzer or computer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclide. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separations may be made prior to counting but are usually not necessary.

Applicability: This method is applicable to the measurement of any gamma emitting radionuclide with gamma energies greater than 20 keV. It can be applied to complex mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gases. The method may also be applied to the analysis of gaseous gamma emitting radionuclides directly in an effluent stream by passing the stream through a chamber or cell containing the detector. ASTM-3649(9), IDO-12096(18).

Filter and charcoal cartridge samples are counted directly on a high-resolution intrinsic germanium detector. The system consists of the detector, a bias supply, a spectrometry amplifier, an analog-to-digital converter, and a pulse height analyzer linked to a multiuser system.

3.4.2 Method G-2, Low Resolution Gamma Spectrometry.

Principle: The sample is counted with a low resolution gamma detector, a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube and connected to a multichannel analyzer. The gamma emitting radionuclides in the sample are measured from the gamma count rates in the energy regions characteristic of the individual radionuclides. Corrections are made for counts contributed by other radionuclides to the spectral regions of the radionuclides of interest. Radiochemical separation may be used prior to counting to obtain less complex gamma spectra if needed.

Applicability: This method is applicable to the measurement of gamma emitting radionuclides with energies greater than 100 keV. It can be applied only to relatively simple mixtures of gamma emitting radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector. ASTM-D-2459(12), EMSL-LV-0539-17(19).

Charcoal cartridge samples are counted directly on a 4-in. by 5-in thallium-activated sodium iodide detector. The system consists of the detector, a high voltage supply, a preamplifier, a linear amplifier, an analog-to-digital converter, and a pulse height analyzer linked to a multiuser system. This method is used to screen charcoal cartridge samples for those samples exhibiting gamma activity levels sufficiently above detection limits to permit gamma component identification by high-resolution gamma spectrometry.

3.4.3 Method G-3, Single Channel Gamma Spectrometry.

Principle: The sample is counted with a thallium activated sodium iodide crystal. The detector is coupled to a photomultiplier tube connected to a single channel analyzer. The activity of a gamma emitting radionuclide is determined from the gamma counts in the energy range for which the counter is set.

Applicability: This method is applicable to the measurement of a single gamma emitting radionuclide. It is not applicable to mixtures of radionuclides. The samples counted may be in the form of particulate filters, absorbers, liquids or gas. The method can be applied to the analysis of gaseous radionuclides directly in an effluent stream by passing the gas stream through a chamber or cell containing the detector.

Single channel gamma spectrometry is not employed at the Analytical Chemistry Laboratory.

3.4.4 Method G-4, Gross Gamma Counting.

Principle: The sample is counted with a gamma detector usually a thallium activated sodium iodine crystal. The detector is coupled to a photomultiplier tube and gamma rays above a specific threshold energy level are counted.

Applicability: Gross gamma measurements may be used to measure emissions of specific radionuclides only when it is known that the sample contains a single radionuclide or the identity and isotopic ratio of the radionuclides in the effluent stream are well known. When gross gamma measurements are used to determine emissions of specific radionuclides periodic measurements using Methods G-1 or G-2 should be made to demonstrate that the gross gamma measurements provide reliable emission data. This method may be applied to analysis of gaseous radionuclides directly in an effluent stream by placing the detector directly in or adjacent to the effluent stream or passing an extracted sample of the effluent stream through a chamber or cell containing the detector.

Gross gamma counting techniques are not included in the analytical plan for the segment of the emissions monitoring program performed by the Analytical Chemistry Laboratory.

3.5 Counting Methods. All of the methods with the exception of Method A-5 involve counting the radiation emitted by the radionuclide. Counting methods applicable to the measurement of alpha, beta and gamma radiations are listed below. The equipment needed and the counting principles involved are described in detail in ASTM-3648(8).

3.5.1 Alpha Counting:

▪ Gas Flow Proportional Counters. The alpha particles cause ionization in the counting gas and the resulting electrical pulses are counted. These counters may be windowless or have very thin windows.

▪Scintillation Counters. The alpha particles transfer energy to a scintillator resulting in a production of light photons which strike a photomultiplier tube converting the light photons to electrical pulses which are counted. The counters may involve the use of solid scintillation materials such as zinc sulfide or liquid scintillation solutions.

▪Solid-State Counters. Semiconductor materials, such as silicon surface-barrier p-n junctions, act as solid ionization chambers. The alpha particles interact which the detector producing electron hole pairs. The charged pair is collected by an applied electrical field and the resulting electrical pulses are counted.

▪Alpha Spectrometers. Semiconductor detectors used in conjunction with multichannel analyzers for energy discrimination.

- **Gas-Flow Proportional Counters. A thin-window gas-flow proportional counting system is employed to perform Methods 3.1.2 and 3.1.4.**
- **Scintillation Counters. An alpha scintillation counter equipped with a zinc sulfide detector may be employed to perform Method 3.1.4.**
- **Solid State Counters. Solid state semiconductor detectors are employed in alpha spectrometry Methods 3.1.1 and 3.1.3 and in gross alpha measurements associated with Methods 3.1.2 and 3.1.4.**

- **Alpha Spectrometers. Solid state semiconductor detector equipped pulse height analyzers are employed to perform Methods 3.1.1 and 3.1.3.**

- **Liquid Scintillation Spectrometers. Liquid scintillation spectrometer systems designed to discriminate between alpha, beta, and gamma activity on a pulse shape basis and on a pulse amplitude basis are operational at the Analytical Chemistry Laboratory, though neither are currently included in the analytical plan for the environmental monitoring program.**

3.5.2 Beta Counting:

▪Ionization Chambers. These chambers contain the beta-emitting nuclide in gaseous form. The ionization current produced is measured.

▪Geiger-Muller (GM) Counters-or Gas Flow Proportional Counters. The beta particles cause ionization in the counting gas and the resulting electrical pulses are counted. Proportional gas flow counters which are heavily shielded by lead or other metal, and provided with an anti-coincidence shield to reject cosmic rays, are called low background beta counters.

▪Scintillation Counters. The beta particles transfer energy to a scintillator resulting in a production of light photons, which strike a photomultiplier tube converting the light photon to electrical pulses which are counted. This may involve the use of anthracene crystals, plastic scintillator, or liquid scintillation solutions with organic phosphors.

▪Liquid Scintillation Spectrometers. Liquid scintillation counters which use two photomultiplier tubes in coincidence to reduce background counts. This counter may also electronically discriminate among pulses of a given range of energy.

- **Ionization Chambers. The analytical plan for the segment of the emissions monitoring program performed by the Analytical Chemistry Laboratory does not include samples suited to this counting technique.**

- **Gas-Flow Proportional Counters. A thin window gas-flow proportional counting system is employed to perform Methods 3.3.1 and 3.3.2.**

- **Scintillation Counters. Solid state beta scintillation detectors are not currently included in the analytical plan for the segment of the emissions monitoring program performed by the Analytical Chemistry Laboratory.**

- **Liquid Scintillation Spectrometer. Liquid scintillation spectrometer systems designed to discriminate between alpha, beta, and gamma activity on a pulse shape basis are not currently operational at the Analytical Chemistry Laboratory. Scintillation techniques that discriminate between alpha and beta activity on a pulse height basis are not included in the analytical plan for the emissions monitoring program performed at the Analytical Chemistry Laboratory.**

3.5.3 Gamma Counting:

▪Low-Resolution Gamma Spectrometers. The gamma rays interact with thallium activated sodium iodide or cesium iodide crystal resulting in the release of light photons which strike a photomultiplier tube converting the light pulses to electrical pulses proportional to the energy of the gamma ray. Multi-channel analyzers are used to separate and store the pulses according to the energy absorbed in the crystal.

▪High-Resolution gamma Spectrometers. Gamma rays interact with a lithium-drifted (Ge(Li)) or high-purity germanium (HPGe) semiconductor detectors resulting in a production of electron-hole pairs. The charged pair is collected by an applied electrical field. A very stable low noise preamplifier amplifies the pulses of electrical charge resulting from the gamma photon interactions. Multichannel analyzers or computers are used to separate and store the pulses according to the energy absorbed in the crystal.

=Single Channel Analyzers. Thallium activated sodium iodide crystals used with a single window analyzer. Pulses from the photomultiplier tubes are separated in a single predetermined energy range.

- **Low Resolution Gamma Spectrometers. A 4-in. by 5-in. thallium-activated sodium iodide detector is employed to perform Method 3.4.2.**

- **High Resolution Gamma Spectrometer. A high-resolution intrinsic germanium detector is employed to perform Method 3.4.1.**

- **Single Channel Analyzers - Single channel gamma spectrometry is not included in the analytical plan for the emissions monitoring program performed at the Analytical Chemistry Laboratory.**

3.5.4 Calibration of Counters. Counters are calibrated for specific radionuclide measurements using a standard of the radionuclide under either identical or very similar conditions as the sample to be counted. For gamma spectrometers a series of standards covering the energy range of interest may be used to construct a calibration curve relating gamma energy to counting efficiency.

In those cases where a standard is not available for a radionuclide, counters may be calibrated using a standard with energy characteristics as similar as possible to the radionuclide to be measured. For gross alpha and beta measurements of the unidentified mixtures of radionuclides, alpha counters are calibrated with a natural uranium standard and beta counters with a cesium-137 standard. The standard must contain the same weight and distribution of solids as the samples, and be mounted in an identical manner. If the samples contain variable amounts of solids, calibration curves relating weight of solids present to counting efficiency are prepared. Standards other than those prescribed may be used provided it can be shown that such standards are more applicable to the radionuclide mixture measured.

The thin-window gas-flow proportional counter that is used for filter sample screening for positive amounts of alpha and beta activity using Methods 3.1.4 and 3.3.2 is calibrated for the alpha-emitting nuclide ^{239}Pu and beta-emitting nuclides ^{90}SrY, ^{99}Tc, and ^{137}Cs using National Institute of Standards and Technology (NIST) traceable standard reference materials fabricated into the filter sample counting geometry configuration. Efficiency data measured for ^{239}Pu have been demonstrated to be applicable to all alpha energies greater than 4.0 MeV. The analytical program specifies that all net beta measurement amounting to less than the 2 sigma uncertainty in the measured beta counting background will be reported as less than a detection limit based on that 2 sigma quantity and calculated as ^{90}SrY. Gross beta results for filter samples exhibiting positive beta activity are calculated using an efficiency that is weighted according to components identified in the sample using Method 3.3.1.

The high-resolution gamma ray spectrometry system that is used for quantitative gamma spectral analysis of filter and charcoal cartridge samples, Method 3.4.1, is efficiency calibrated using a mixed nuclide certified standard and individual NIST traceable standard reference solutions of ^{60}Co, ^{131}I, ^{133}Ba, ^{137}Cs, and ^{152}Eu fabricated into the charcoal cartridge counting geometry configuration. The emissions monitoring program plan (PNL 1990) specifies that charcoal cartridge samples exhibiting no ^{131}I activity at the 364 KeV principal gamma energy shall be reported as containing less than an ^{131}I detection limit calculated using the 2 sigma uncertainty in the measured spectrum background at that energy.

3.6 Radiochemical Methods for Selected Radionuclides. Methods for a selected list of radionuclides are listed in Table 1. The radionuclides listed are those which are most commonly used and which hove the greatest potential for causing doses to members of the public. For radionuclides not listed in Table 1,

methods based on any of the applicable "principles of measurement" described in Section 3.1 through 3.4 may be used.

Filter and charcoal cartridge samples found to contain significant alpha, beta, or gamma activity components during screening under Methods 3.1.4, 3.3.2, and 3.4.2 that cannot be quantitatively determined by gamma spectral analysis using Method 3.4.1 are analyzed using counting Methods 3.1.1, 3.1.2, and 3.3.1. Volume 7 of the Analytical Chemistry Laboratory Manual (PNL 1990) contains established procedures for separation and measurement of selected radionuclides not specific to the emissions monitoring program plan that can be applied to filter and charcoal sample analysis.

3.7 Applicability of Gross Alpha and Beta Measurements to Unidentified Mixtures of Radionuclides. Gross alpha and beta measurements may be used as a screening measurement as a part of an emission measurement program to identify the need to do specific radionuclide analyses or to confirm or verify that unexpected radionuclides are not being released in significant quantities.

Gross alpha (Method A-4) or gross beta (Methods B-2 or B-4) measurements may also be used for the purpose of comparing the measured concentrations in the effluent stream with the limiting "Concentration Levels for Environmental Compliance" in Table 2 of Appendix E. For unidentified mixtures, the measured concentration value shall be compared with the lowest environmental concentration limit for any radionuclide which is not known to be absent from the effluent stream.

Methods 3.1.4 and 3.3.2 gross activity measurements are used only as a screening procedure to identify those filter samples containing significant amounts of alpha and beta activity, respectively. Detection limit values calculated using the 2 sigma uncertainty in the respective measured backgrounds are reported for samples exhibiting net activities less than these uncertainties.

4.0 Quality Assurance Methods

Each facility required to measure their radionuclide emissions shall conduct a quality assurance program in conjunction with the radionuclide emission measurements. This program shall assure that the emission measurements are representative, and are of known precision and accuracy and shall include administrative controls to assure prompt response when emission measurements indicate unexpectedly large emissions. The program shall consist of a system of policies, organizational responsibilities, written procedures, data quality specifications, audits, corrective actions and reports. This quality assurance program shall include the following program elements:

4.3.5 A description of the laboratory analysis procedures used for each radionuclide measured. including frequency of analysis calibration procedures and frequency of calibration.

Particulate matter filter samples and gaseous material charcoal absorption samples are collected from the various sampling sites on a scheduled, usually weekly, basis by Westinghouse Hanford personnel. These samples are delivered to the Analytical Chemistry Laboratory, 325 Building, 300 Area.

Calibration procedures for all counting instruments employed in the performance of analytical measurements described for emission monitoring program samples in Volume 6 of the Analytical Chemistry Laboratory Manual are documented in that manual (PNL 1990).

The filter and charcoal cartridge samples that constitute the Analytical Chemistry Laboratory emissions monitoring program rarely exhibit positive gross alpha, gross beta, or gamma activity, excepting naturally occurring radon daughter activity when certain atmospheric conditions exist. For samples exhibiting net activities less than the 2 sigma uncertainty of

the applicable counting instrument measured background, these 2 sigma uncertainties are used to calculate maximum possible limits for possible alpha, beta, and gamma emissions. Calculation conventions for gross count data are described in Table II, Section 3.5.4, Calibration of Counters (PNL 1990).

Filter samples exhibiting net alpha activity greater than the 2 sigma uncertainty in the measured beta counting system background are quantitatively analyzed by chemical destruction of the filter medium followed by direct total alpha and alpha spectral measurement of the resulting solution.

Filter samples exhibiting net beta activity greater than the 2 sigma uncertainty in the measured alpha counting system background are quantitatively analyzed by direct high-resolution gamma ray spectrometry. When data indicate possible presence of pure beta-emitting radionuclides in a filter sample, quantitative analytical methods for ^{90}SrY, ^{99}Tc, and ^{147}Pm, documented in Volume 7 of the Analytical Chemistry Laboratory Manual (PNL 1990) are performed.

4.5 A quality control program shall be established to evaluate and track the quality of the emissions measurement data against preset criteria. The program should include where applicable a system of replicates, spiked samples, split samples, blanks and control charts. The number and frequency of such quality control checks shall be identified.

Quality control procedures governing calibration and control of counting instruments employed in the emissions monitoring program are documented in the Analytical Chemistry Laboratory Manual, PNL-MA-599, Vol. 5. Counting instrument performance is monitored by the use of "control" sources consisting of selected radionuclides exhibiting energy range extremes which are established simultaneously with instrument calibration. Control sources are remeasured daily; so long as a control measurement result falls within 3 sigma limits established for the original control data, instrument calibration is assumed to remain valid. Should a control count exceed a 2 sigma limit, a remeasurement is performed; should both measurements fall outside a 3 sigma limit, the instrument is referred to a cognizant scientist for further testing and referral to instrument repair services. When an instrument is returned to service, it is recalibrated and new controls are established. Alpha proportional counting systems are controlled using ^{239}Pu sources, alpha spectral analyzers with a mixed ^{237}Np + ^{239}Pu + ^{241}Am source, and beta proportional counting systems with individual ^{99}Tc, ^{147}Pm, and ^{90}SrY sources. High resolution gamma spectral analyzers are controlled with either a mixed ^{241}Am + ^{137}Cs + ^{60}Co source or a ^{152}Eu + ^{137}Cs + ^{60}Co source, while low resolution gamma spectral analyzers are controlled with individual ^{57}Co and ^{60}Co sources.

Counting system backgrounds are measured at least once each working day; long background measurements are performed over weekends.

A control chart is used to evaluate current performance of each counting instrument and to identify trends in performance. Control of each instrument is determined at least once each working day before the instrument is used. All calibration data, control data, and background data are recorded directly into a laboratory record book dedicated to

that specific instrument. Control charts and instrument maintenance and repair records are included in the same volume.

The individual procedures for quantitative determination of specific nuclides documented in Volume 7 of PNL (1990) specify replicate analysis, internal standards, and other quality-related operations in performance of radiochemical analysis where applicable.

REFERENCE

PNL, 1990, *Analytical Chemistry Laboratory Manual*, Volumes 6 and 7, PNL-MA-597, Pacific Northwest Laboratory, Richland, Washington.

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APPENDIX I

METHOD 114 COMPARISON FOR STACK 291-T-1

To be determined by J. H. Mizner, Jr.

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